MAC® 1200
Operator's Manual

Version 1
227 492 04 GA (USA) Revision C

marquette

A GE Medical Systems Company

The information contained in this manual describes version 1.0 of the MAC® 1200 electrocardiograph and reflects software version 5.0.

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Revision History

This manual is subject to the GE Marquette change order service. The revision letter which follows the document part number, changes with every update of the manual.

Part No./ Revision	Date	Comment
227 492 04-A	January 1999	Initial Release
227 492 04-B	March 17, 1999	ECO 061 952
227 492 04-C	May 7, 1999	ECO 062 136

MAC 1200 Option Codes

In addition to the software supplied with the unit, optional programs may be purchased to upgraded the MAC 1200 performance features. In order to use a new option, you need to activate it by entering the option code number (refer to section 9.8 for details). The option codes are entered into the MAC 1200 prior to shipping.

Software package	Functionality	Option Code
MEAS	measurement (measurement of the 10-second resting ECG)	_ _ _ _ _ _ _ _ _ _ _ _
DIAG	interpretation (interpretation of the 10-second resting ECG)	_ _ _ _ _ _ _ _ _ _ _ _
MEMO	memory (storage of a maximum of 40 10-second resting ECGs)	_ _ _ _ _ _ _ _ _ _ _ _
C100	activates the three options MEAS, DIAG, MEMO for a maximum of 100 ECGs	_ _ _ _ _ _ _ _ _ _ _ _
C500	activates the three options MEAS, DIAG, MEMO for a maximum of 500 ECGs	_ _ _ _ _ _ _ _ _ _ _ _
EVAL	activates the three options MEAS, DIAG, MEMO for a maximum of 4 weeks	_ _ _ _ _ _ _ _ _ _ _ _

Serial No:	_ _ _ _ _ _ _ _ _ _

How To Reach Us

Service calls

Contact various service, supplies, and repair personnel using the following telephone numbers and addresses.

To open a service call with Marquette Service, call:

USA	1-800-558-704 (24-hour service)
Other countries	561-575-5000 (during U.S. business hours only)

or contact your local sales and service representative.

Supply products and service parts

Order supplies (leadwires, electrode paste, thermal paper, etc.) or service parts ((circuit boards, cables, software, etc.) and manuals from.

Marquette Service and Supplies
Attn: Supplies (or Service Parts)
P.O. Box 9100, 100 Marquette Drive
Jupiter, FL 33468-9100

Telephone:	1-800-558-5102 (U.S. only) 561-575-5070 (outside U.S.)
Fax:	561-575-5050

Have the following information handy:

- part number of the defective part, or
- model and serial number of the equipment,
- part number/name of the assembly where the item is used,
- item name, and
- where applicable, reference designation (eg. R13, S12)

When ordering additional operator manuals, remember to get the software version from either the back of the title page or a printed report.

Tech support

Tech Support has the most current information about your equipment, and can provide assistance with any technical questions or problems.

- Resting ECG analysis systems
  1-800-558-7072
- Exercise testing systems
  1-800-558-7072
- Ambulatory ECG analysis and editing systems
  1-800-558-6802
- MARS™ unity workstation
  1-800-282-6297
- MUSE® cardiology management systems:
  D-Series (errors/hardware problems)
  1-800-558-7070
  Network systems (errors/hardware problems)
  1-800-645-9309

Applications ("How to..." questions)

- All diagnostic cardiology products—except MARS
  CRS (full disclosure) software
  1-800-531-5613
- MUSE CardioWindow cath lab information systems 1-800-343-9341
- MARS clinical review station (full disclosure) software

USA	1-800-992-0344
Canada	1-800-874-4357
United Kingdom	0800-89-1645
Other countries	414-255-9831

Repairs

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Some Marquette products (MAC® PC resting ECG analysis systems, acquisition modules, and Holter recorders) are repaired on a 48-hour turnaround basis. Send items for 48-hour repair to:

Marquette Service and Supplies
Attn: 48-Hour Turnaround Repair
100 Marquette Drive
Jupiter, FL 33468-9100
Telephone: 1-800-552-3246 (Holter recorders) or 1-800-558-7072 (MAC PC systems and acquisition modules)

Diagnostic hardware

Send all items except 48-hour turnaround repair items to the above address, Attention: Diagnostic Hardware Repair, Telephone: 1-800-558-5102.

Service Agreements

For information about service agreements call: 1-800-552-3248.

Other questions or problems

For additional information contact one of the offices listed below.

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1-18-9, Nishi-Waseda
Shinjuku-KuTokyo, Japan
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Fax: (852) 2804 1776

Southeast Asia

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#2 Leng Kee Road
04-04A Thye Hong Centre
Singapore 0315
Telephone: (65) 471-2133
Fax: (65) 471-1540

General Information

- Standards compliance:

  European Council Directive 93/42/EEC

  IEC60601-1-2/EN 60601-1-2 "Electromagnetic Compatibility - Medical Electrical Equipment".

  CISPR11 / EN 55011 "Radio interference emission"

  IEC 60601, protection class I

  MDD class IIb

  UL 2601-1

- The symbol ⚠ means: Consult accompanying documents. It indicates points which are of particular importance in the operation of the device.
- The warranty does not cover damage resulting from the use of accessories and consumables from other manufacturers.
- On request Marquette will provide a service manual.
- The Marquette quality management system complies with the standards EN ISO 9001 and EN 46001.

1 INTENDED USE AND FUNCTIONAL DESCRIPTION 9

2 CONTROLS AND INDICATORS 10

3 PUTTING THE DEVICE INTO OPERATION AND PERFORMANCE TEST 12

3.1 SAFETY INFORMATION 12
3.2 POWER SUPPLY 16
3.3 INSTALLATION AND MAINS CONNECTION 17
3.4 PERFORMANCE CHECK 17
3.5 GENERAL DEVICE SETTINGS 18
3.6 CONNECTING EXTERNAL DEVICES 19
3.7 CONTRAST ADJUSTMENT 19

4 PREPARATIONS FOR ECG RECORDING 20

4.1 CONNECTING THE PATIENT CABLE 20
4.2 APPLYING THE ELECTRODES 20
4.3 ARTIFACT DUE TO POOR ELECTRODE APPLICATION 22
4.4 ENTERING PATIENT DATA 23

5 RECORDING IN 12 LEAD MODE 25

5.1 SOME BASIC FACTS 25
5.2 RECORDING 26
5.3 THE MEMORY FUNCTION 28
5.4 THE REPORT FORMATS 29
5.5 ECG TRANSMISSION VIA MODEM 30
5.6 BRIEF OPERATING INSTRUCTIONS - 12 LEAD MODE 33

6 RECORDING IN 6 LEAD MODE 34

6.1 SOME BASIC FACTS 34
6.2 RECORDING 34
6.3 BRIEF OPERATING INSTRUCTIONS - 6 LEAD MODE 36

7 ARRHYTHMIA MODE 37

7.1 SOME BASIC FACTS 37
7.2 RECORDING 38
7.3 BRIEF OPERATING INSTRUCTIONS - ARRHYTHMIA MODE 40

8 ECGS OF PACEMAKER PATIENTS / ECG RECORDING DURING DEFIBRILLATION 41

9 SYSTEM SETUP 42

9.1 SOME BASIC FACTS 42
9.2 12 LEAD MODE 42
9.3 6 LEAD MODE 44
9.4 ARRHYTHMIA MODE 45
9.5 GENERAL DEVICE SETTINGS 46
9.6 COMMUNICATION 47
9.7 PATIENT DATA 48
9.8 OPTION CODE 48

10 LOADING CHART PAPER 49

11 CLEANING, DISINFECTION AND MAINTENANCE 51

11.1 CLEANING AND DISINFECTING THE RECORDER HOUSING 51
11.2 CLEANING AND DISINFECTING THE PATIENT CABLE 51
11.3 CLEANING AND DISINFECTING THE ELECTRODES 51
11.4 MAINTENANCE 52

12 TROUBLESHOOTING 53

13 TECHNICAL SPECIFICATIONS 55

INDEX 61

1 Intended Use and Functional Description

The MAC 1200 is an ECG acquisition and recording system designed and manufactured by Marquette Medical Systems.

- It is intended to be used for resting ECG recording and realtime ECG recording with or without arrhythmia detection.
- It is not intended for use as a vital signs physiological monitor.
- The arrhythmia detection portion of the MAC 1200 is provided to the customer for the convenience of automatic documentation. It is not designed to provide alarms for arrhythmia detection.
- The MAC 1200 offers no diagnostic opinion to the user. Instead it provides analytical statements when configured with the appropriate options.
- It is intended to be used by trained operators under direct physician supervision when ECG records are required.
- It is suitable for intracardiac application.
- It is designed for continuous operation.
- It is not intended for home use.
- The MAC 1200 is designed as a portable device and can easily be moved from one patient to another or to different locations. It is not intended to be used during patient transport.

Equipped with the standard software, the MAC 1200 supports the following operating modes:

- 12 Lead Mode (acquisition of 12 leads of ECG for a period of 10 seconds) and
- 6 Lead Mode (real-time recording of 6 ECG leads
- Arrhythmia Mode (continuous ECG analysis for arrhythmias).

The graphics display shows 3 leads at a time.

Resting ECGs can be transferred to the MUSE CV Information System via the RS232 interface.

The device operates from both AC and DC (rechargeable batteries) power sources.

The unit's performance features can be upgraded with the following optional programs:

- MEAS - measurement (measurement of the 10-second resting ECG)
- DIAG - interpretation (interpretation of the 10-second resting ECG)
- MEMO - memory (storage of a maximum of 40 10-second resting ECGs)
- C100 - activates the three options MEAS, DIAG, MEMO for a maximum of 100 ECGs
- C500 - activates the three options MEAS, DIAG, MEMO for a maximum of 500 ECGs
- EVAL - activates the three options MEAS, DIAG, MEMO for a maximum of 4 weeks

The electrocardiograph has a setup menu to customize the system parameters.

Patient and user data can be entered for reliable and safe archiving of patient records. The patient name is annotated on each printed report page. All other data are printed on request.

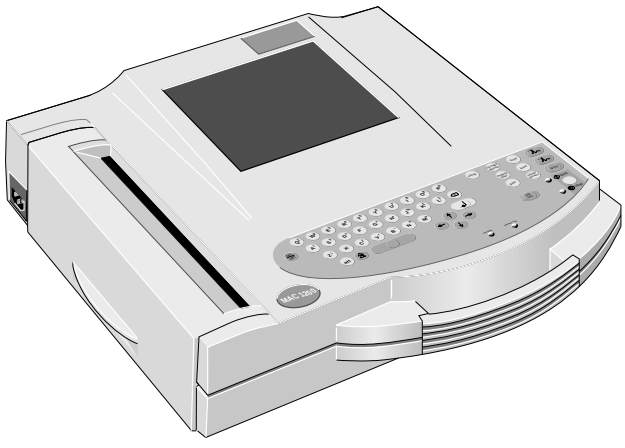


Figure 1-1. MAC 1200

2 Controls and Indicators

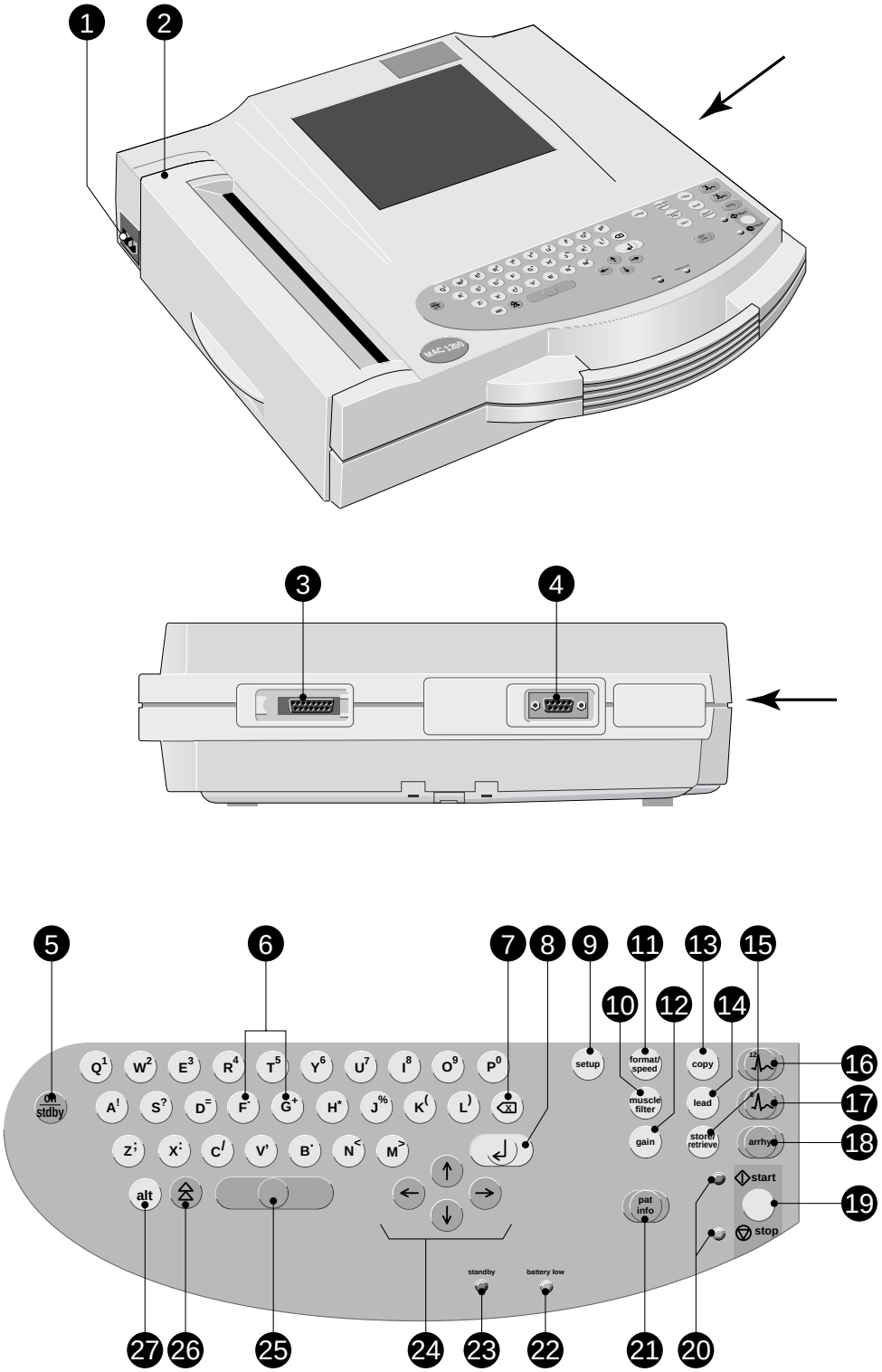


Figure 2-1. Controls and indicators of the MAC 1200 electrocardiograph

1 *Power input*

2 *Paper door, windows allows you to check the paper supply*

3 *Patient cable connector*

4 *Serial interface (see chapter 13 "Technical Specifications")*

5 *Power switch (ON/STANDBY)*

6 *Keys to select a higher or lower HR alarm limit*

7 *Backspace key (to correct entered data)*

8 *Confirms entered data (Enter)*

9 *Displays the setup menu*

10 *Enables/disables the muscle filter (elimination of muscle artifact)*

11 *Selects the writer speed (25, 50, 5 mm/s) in 6 Lead Mode and the report formats in 12 Lead Mode*

12 *Selects the gain (5, 10, 20, 40 mm/mV)*

13 *Press to print the report or additional copies of the ECG, or to send/receive ECGs*

14 *Selects the ECG lead in 6 Lead Mode (in 12 Lead Mode, on the display only)*

15 *Sends ECG to memory/retrieves ECG from memory*

16 *Selects the 12 Lead Mode*

17 *Selects the 6 Lead Mode*

18 *Selects the Arrhythmia Mode*

19 *Starts/stops the selected operating mode, exits the setup menu and patient data entry*

20 *Indicators, green: selected mode started, amber: selected mode stopped*

21 *Enables entry of patient data*

22 *Indicator is illuminated when battery needs to be charged*

23 *Indicator is illuminated when unit is connected to the power line*

24 *Cursor control keys*

25 *Space bar*

26 *Shift key*

27 *Press to access special characters*

Explanation of symbols used on the device

Consult accompanying documents

Signal input

Type CF signal input, highly insulated, defibrillation-proof

Start

Stop

3 Putting the Device into Operation and Performance Test

3.1 Safety Information

- This manual is an integral part of the device. It should always be kept near the device. Close observance of the information given in the manual is a prerequisite for proper device performance and correct operation and ensures patient and operator safety. **Please note that information pertinent to several chapters is given only once. Therefore, carefully read the manual once in its entirety.**
- Patient safety, the specified measuring accuracy, and interference-free operation can be guaranteed only if original Marquette components are used. The user is responsible for application of accessories from other manufacturers.
- This manual is in conformity with the device specifications and standards on safety of electromedical equipment valid at the time of printing. All rights are reserved for devices, circuits, techniques, software programs, and names appearing in this manual.
- The terms danger, warning, and caution are used throughout this manual to point out hazards and to designate a degree or level of seriousness. Hazard is defined as a source of potential injury to a person.

Danger
indicates an imminently hazardous situation which, if not avoided WILL result in death or serious injury.

Warning
indicates a potentially hazardous situation which, if not avoided, COULD result in death or serious injury.

Caution
indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or product/property damage.

- Marquette is responsible for the effects on safety, reliability, and performance of the device, only if
  - assembly operations, extensions, readjustments, modifications, or repairs are carried out by persons authorized by Marquette,
  - the electrical installation of the relevant room complies with the requirements of the appropriate regulations, and
  - the device is used in accordance with the instructions for use.

The safety statements presented in this chapter refer to the equipment in general and, in most cases, apply to all aspects of the device. There are additional safety statements in the other chapters which are specific to the topic described. The order in which safety statements are presented in no way implies order of importance.

DANGERS

EXPLOSION HAZARD — Do not use this equipment in the presence of flammable anesthetics, vapors or liquids.

WARNINGS

ACCESSORIES (SUPPLIES) — Use only the original Marquette cables. Do not connect other signal sources to the cables. The responsibility for the use of accessories from other manufacturers lies with the user.

ACCIDENTAL SPILLS — To avoid electric shock or device malfunction liquids must not be allowed to enter the device. If liquids have entered a device, take it out of service and have it checked by a service technician before it is used again.

BEFORE USE — Before putting the system into operation visually inspect all connecting cables for signs of damage. Damaged cables and connectors must be replaced immediately.

BEFORE USE — Before using the device, the operator must verify that it is in correct working order and operating condition. For instructions, refer to section 3.2.2 "Performance Check" in this chapter.

CONDUCTIVE CONNECTIONS — Do not allow electrodes to come into contact with conductive parts. The neutral electrode, in particular, must not be connected to earth.

DISCONNECTION FROM MAINS — When disconnecting the system from the power line, remove the plug from the wall outlet first. Then you may disconnect the power cord from the device.

MOISTURE CONDENSATION — Devices intended for emergency application must not be stored or transported at temperatures which cause moisture condensation at the application site. Wait until all moisture condensation has evaporated before using the device.

MPSO—The use of a multiple portable socket outlet (MPSO) for a system will result in an enclosure leakage current equal to the sum of all individual earth leakage currents of the system if there is an interruption of the MPSO protective earth conductor. Do not use an additional extension cable with the MPSO as it will increase the chance of the single protective earth conductor interruption.

OPERATOR — The user must have received adequate training in the use of the MAC 1200 and must be capable of applying it properly.

POWER SUPPLY — The device must be connected to a properly installed power outlet with protective earth contacts only. If the installation does not provide for a protective earth conductor, disconnect the monitor from the power line and operate it on battery power, if possible.

If the installation of this equipment in the USA will use 240V rather than 120V, the source must be a center-tapped, 240V, single phase circuit.

CAUTIONS

MAINTENANCE — Regular preventive maintenance should be carried out annually, inspections of equipment with measuring functions should be done every two years (refer to chapter 11 "Cleaning, Disinfection and Maintenance").

PERFORMANCE CHECKS — Check the device performance once a month, strictly following the instructions outlined in section 3.2.2 "Performance Check".

POWER REQUIREMENTS — Before connecting the device to the power line, check that the voltage and frequency ratings of the power line are the same as those indicated on the unit's label. If this is not the case, do not connect the system to the power line until you adjust the unit to match the power source.

VENTILATION REQUIREMENTS — Set up the device in a location which affords sufficient ventilation. The ventilation openings of the device must not be obstructed. The ambient conditions specified in the technical specifications must be ensured at all times.

DEFIBRILLATOR PRECAUTIONS — Patient signal inputs labeled with the CF and BF symbols with paddles are protected against damage resulting from defibrillation voltages To ensure proper defibrillator protection, use only the recommended cables and leadwires. Proper placement of defibrillator paddles in relation to the electrodes is required to ensure successful defibrillation.

DISPOSAL — Dispose of the packaging material, observing the applicable waste control regulations and keeping it out of children's reach.

ELECTROCAUTERY PRECAUTIONS — To prevent unwanted skin burns, apply electrocautery electrodes as far as possible from all other electrodes, a distance of at least 15 cm/ 6 in. is recommended.

EMC — Magnetic and electrical fields are capable of interfering with the proper performance of the device. For this reason make sure that all external devices operated in the vicinity of the monitor comply with the relevant EMC requirements. X-ray equipment or MRI devices are a possible source of interference as they may emit higher levels of electromagnetic radiation.

INTERFACING OTHER EQUIPMENT — Devices may only be interconnected with each other or to parts of the system when it has been determined by qualified biomedical engineering personnel that there is no danger to the patient, the operator, or the environment as a result. In those instances where there is any element of doubt concerning the safety of connected devices, the user must contact the manufacturers concerned (or other informed experts) for proper use. In all cases, safe and proper operation should be verified with the applicable manufacturer's instructions for use, and system standards IEC 60601-1-1/EN 60601-1-1 must be complied with.

NOTES

- The MAC 1200 is designed to comply with IEC 60601/ EN 60601 requirements. It is Class I equipment and has a built-in rechargeable electrical power source. The device is suitable for intracardiac use. The device is suitable for continuous operation.
- Choose a location which affords an unobstructed view of the monitor's screen and easy access to the operating controls.
- The MAC 1200 has no additional protection against ingress of water.
- Medical technical equipment such as the MAC 1200 must only be used by persons who have received adequate training in the use of such equipment and who are capable of applying it properly.
- At the end of its service life; the MAC 1200 and its accessories must be disposed of in compliance with the special waste control regulations for electronic parts. If you have any questions in this matter, please contact Marquette Medical Systems.

Literature

Medical Device Directive 93/42/EEC

EN 60601-1/1990 + A1: 1993 + A2: 1995: Medical electrical equipment. General requirements for safety

EN 60601-1-1/9.1994 + A1 12.95: General requirements for safety. Requirements for the safety of medical electrical sys-tems. Requirements for the safety of medical electrical systems.

EN 60601-2-25/1993: Medical electrical equipment. Part 2: Special requirements for the safety of electrocardiographs.

IEC Publication 513/1994: Fundamental aspects of safety standards for medical equipment.

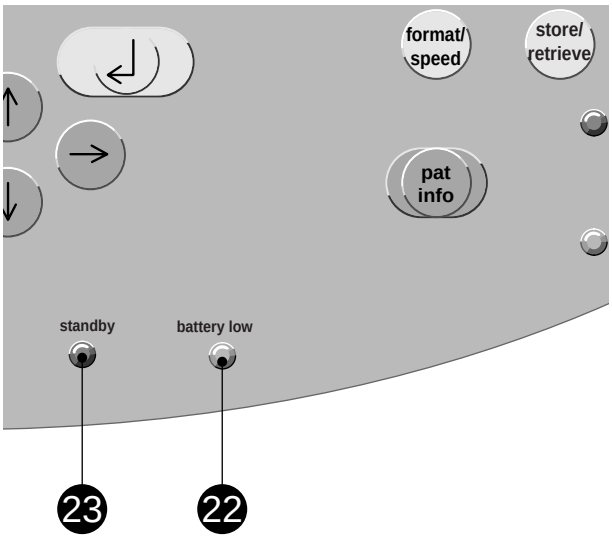


Figure 3-1. Indicators

3.2 Power Supply

The units are powered from the power line or from the rechargeable battery.

The battery charges automatically when the unit is connected to the power line and the **standby** indicator **23** is illuminated (Figure 3-1). It is not necessary to switch on the device for charging. To ensure that the battery is always fully charged, leave the electrocardiograph connected to the power line whenever possible. After 4 hours the battery has regained its full capacity.

The **battery low** indicator **22** is illuminated when battery needs to be charged.

With a full battery, about 50 ECGs can be recorded in 12 Lead Mode. When its capacity drops to about 25 recordings, the battery is used up and must be replaced by a service specialist.

Caution

To prolong the battery life, discharge the battery at least once per month (by operating the electrocardiograph on battery power).

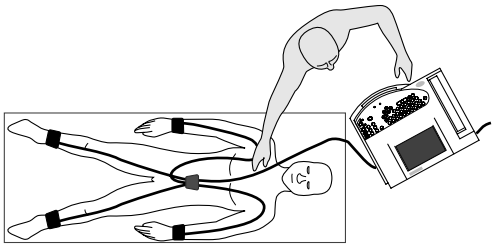


Figure 3-2. Arranging device and couch

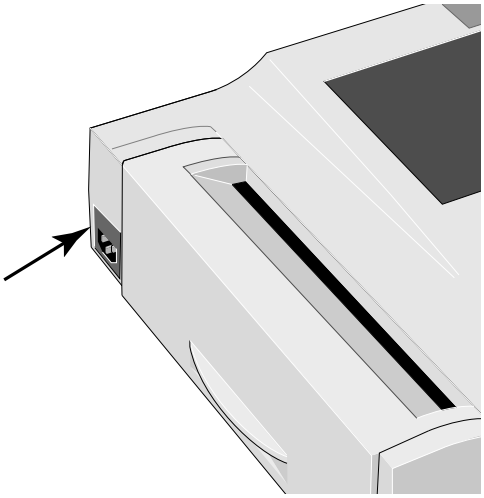


Figure 3-3. AC power input

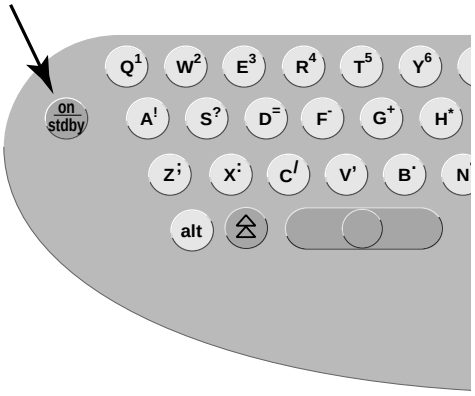


Figure 3-4. Power switch

Tip

When turning off the MAC 1200 (standby mode), be sure to press the power switch long enough.

Tip

The backlighting of the display switches off automatically when no key is activated for 5 min (adjustable).

3.3 Installation and Mains Connection

Figure 3-2 shows a practical arrangement of patient and recorder. For interference-free operation, it is important that the patient cable and the power cord do not run parallel.

- Using the power cord, connect the device to the power line (Figure -3-1). Use only the original power cord or an equivalent cable.

The **standby** indicator **23** will illuminate.

- Check the paper supply (the window in the paper door allows you to look inside the compartment). If it is necessary to insert a new paper pad, refer to chapter 10 for instructions.

3.4 Performance Check

- Press the power switch to switch on the device (Figure 3-4).

The amber **stop** indicator ▽ **20** will illuminate.

After power-up, the electrocardiograph runs an automatic self-test. When no problem is detected, it defaults to the 12 Lead Mode. If a malfunction is identified, the display will show an error message "Error...". In this situation, notify service to check and repair the device.

3.5 General Device Settings

The table at left shows the general device settings that can be modified and the system defaults.
For instructions on changing the device setup, refer to section 9.5 "General Device Settings".

Parameter	**System Defaults**	**Options**
Ordering Physician	empty text box	selection from a list of 10 names
Referring Physician	empty text box	selection from a list of 10 names
Technician	empty text box	selection from a list of 10 names
Institution Name	empty text box	text box (30 chrs)
Date (dd.mm.yyyy)	current date	
Time (hh:mm)	current time	
Lead Fail Beep	No	Yes
High HR Beep	No	Yes
Lead Labels	AAMI	IEC
Date	mm/dd/yyyy	dd.mm.yyyy
Time	12	24
Units	in, lb	cm, kg
Mains	60 Hz	50 Hz
LCD light off after	5 min	1 to 99 minutes
Default mode	12 Lead	6 Lead, Arrhythmia
Language	English	English, French, Spanish
Restore defaults	No	Yes
Print setup lists	No	Yes
Test DATA	No	Yes

Warning

- ***Connecting external devices to the RS232 interface of the electrocardiograph creates a medical system. This system must meet the requirements of IEC 60601-1-1:***
- ***use only the original Marquette connection cables***
- ***all non-medical devices of a system must be connected to the same electric circuit. Devices which are not connected to the same circuit must be electrically isolated (use isolated RS232 interface as per IEC 60601-1).***
- ***Modems connected to the electrocardiograph must meet the requirements of EN 60950 or UL1950 (all modems recommended by Marquette meet these requirements). The specific regulations valid in your country must also be observed.***

3.6 Connecting External Devices

Via the serial interface, the electrocardiograph can be connected to a MUSE CV Information System. These external devices can be connected directly or via a modem. Please contact Marquette Application Support for details. Resting ECGs acquired in the 12 Lead Mode as well as the corresponding data can be transferred to these external devices (see section 5.5 "ECG Transmission via Modem").
The table below shows the system defaults and all possible adjustments.
For instructions on changing the default setup, refer to section 9.6 "Communication".

Parameter	**System defaults**	**Options**
Choices for "Modem → Other"		
		none user-defined MultiTech 19.32 MultiTech 56.6 Elsa 14.4 Elsa 28.8 Elsa 33.6
Choices for "Modem → user-defined"		
telephone init string dial string hangup	 AT&FM0&D0 &Q1V0 ATDT +++ATH	
Choices for "Modem → MultiTech 19.32, 56.6, ELSA 14.4, ELSA 28.8, 33.6"		
dial mode phone outside line	tone	pulse 0 to 9 (28 digits) 0 to 9 (10 digits)

3.7 Contrast Adjustment

- Simultaneously press alt and the appropriate cursor key: more contrast ↑, less contrast ↓.

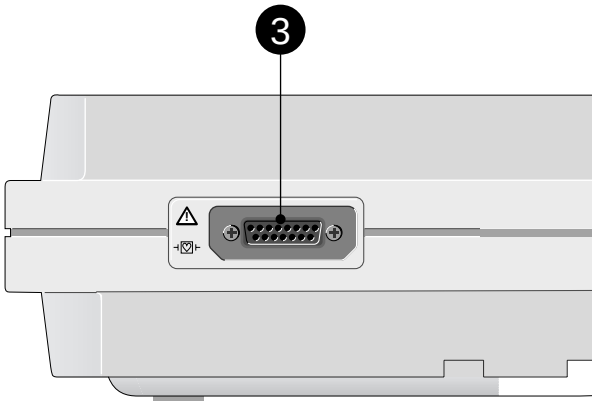


Figure 4-1. ECG signal input

Warning

For reasons of patient safety, use only the original Marquette patient cable. Before connecting the cable to the device, check it for signs of mechanical damage. Do not use a damaged cable.

Caution

When the patient may have to be defibrillated while the ECG is being recorded, be sure to use only silver-silver chloride electrodes. (Refer to chapter 8 "ECG Recording during Defibrillation".)

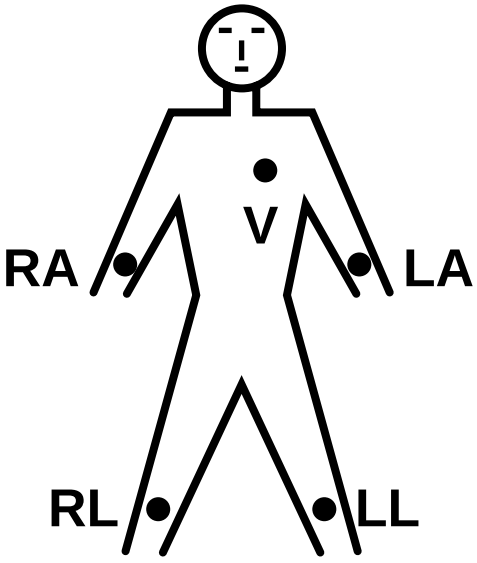


Figure 4-2. Applying limb-lead electrodes

4 Preparations for ECG Recording

4.1 Connecting the Patient Cable

Use the 10-leadwire patient cable for acquisition of the 12 standard ECG leads.

- Connect the patient cable to connector **3** (Figure 4-1).

4.2 Applying the Electrodes

Careful application of the electrodes and skin preparation is the key to an interference-free ECG.

4.2.1 Applying Electrodes (Limb Leads)

Refer to the illustration shown in Figure 4-2.

RA (white)	electrode on right arm
LA (black)	electrode on left arm
LL (red)	electrode on left leg
RL (green)	electrode on right leg

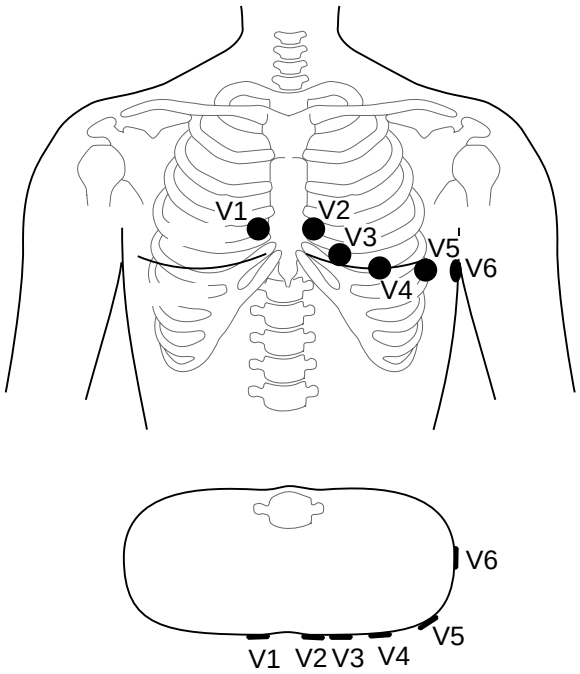


Figure 4-3. Chest electrode placement

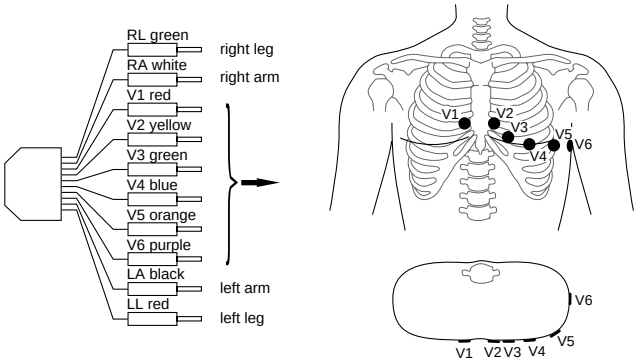


Figure 4-4. Connecting the patient cable (10-lead cable, standard ECG leads)

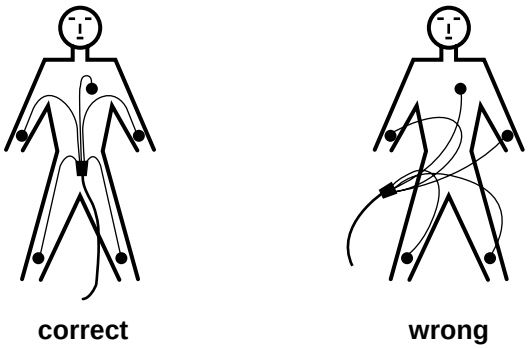


Figure 4-5. Arranging the patient cable

4.2.2 Applying Electrodes (Thorax)

- Shave application points, if necessary.

4.2.3 Electrode Placement for Standard Leads (I, II, III, aVR, aVL, aVF, VI...V6)

For acquisition of the standard ECG leads four electrodes must be applied on the limbs and six on the chest. The limb electrodes should be placed above the wrists and ankles. Figure 4-3 shows the chest electrode application points.

V1 4th intercostal space at the right border of the sternum

V2 4th intercostal space at the left border of the sternum

V3 midway between locations V2 and V4

V4 at the mid-clavicular line in the 5th intercostal space

V5 at the anterior axillary line on the same horizontal level as V4 and V6

V6 at the mid-axillary line on the same horizontal level as V4

- Connect the 10-lead patient cable as shown in Figure 4-4.

- Arrange the leadwires and patient cable as shown in Figure 4-5.

4.3 Artifact Due to Poor Electrode Application

The electrocardiograph is equipped with state-of-the-art electronic utilities that ensure artifact-free recordings. Among these are the automatic baseline adjustment and the anti-drift system (cubic splinie) (ADS).
At the beginning of the recording the automatic baseline adjustment algorithm verifies the incoming signal and adjusts the baseline position accordingly.

During the recording, the anti-drift system (cubic spline) continuously checks the baseline position and returns it to the normal level, if required (Figure 4-6).

When electrodes are not properly applied, these measures may not fully compensate for artifact. High polarization voltages induced by electrodes applied without conductive gel may cause the amplifier to overrange, so that a straight line will be recorded instead of the ECG (see Figure 4-6). The device will then automatically block and return the baseline to its normal position. A baseline is then recorded for approx. 1 second. It is possible to block the amplifiers manually by disconnecting the RL electrode.

On the display this condition is indicated by **** instead of the electrode label (e.g. at **i**, Figure 5-1).

Remedy

- Apply the electrodes according to instructions.
- Do not apply the electrodes on top of clothing.
- Use a contact agent with reusable electrodes (e.g. moistened electrode paper, electrode cream, spray, etc.).
- Wait approx. 10 seconds before initiating a recording. After the 10-second period, the automatic functions are enabled and the polarization voltages have stabilized, provided the electrodes are properly applied. In case of improper electrode application, an error message will appear on the display (RL, LL, LA, LL, V1 to V6).
- If required, the ADS (cubic spline) and the filters (20/40 Hz, 60 Hz) can be disabled to verify the "raw" ECG signal.

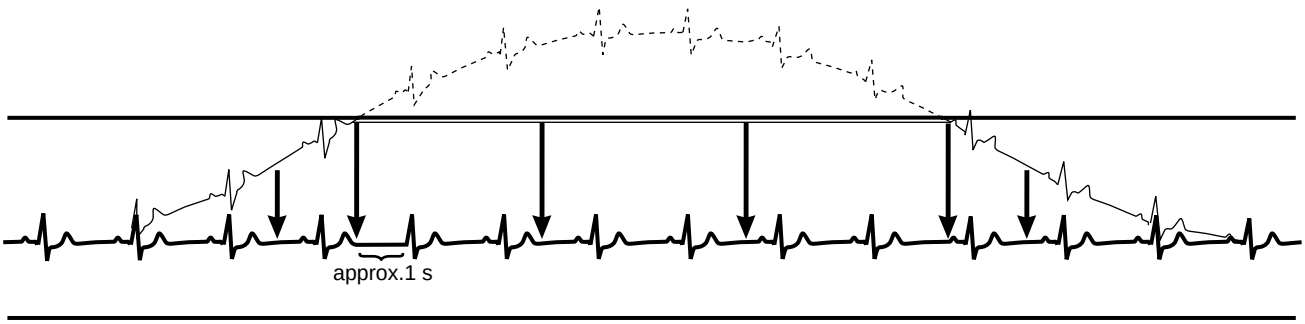


Figure 4-6. Sample recording

4.4 Entering Patient Data

It is possible to enter patient data and have them annotated on the recording for easy archiving of patient records.

- Press pat info to enter the patient data mode.

– The recorder displays the menu items in a defined order.

– To skip a menu item, press ↵ or the cursor key ↓ or ↑.

– It is not possible to write capital and small letters (do not use the Shift key).

– For entry of numbers (e.g. date of birth), it is not necessary to press the Shift key.

– All entries must be confirmed with ↵.

– Press pat info or ◇ ▽ to exit the patient data mode.

The table below shows the menu items in the correct order. On the display, selected options are shown in brackets. Refer to section 9.7 for details on configuring the patient data prompts.

Parameter	**System Defaults**		**Options**
	Entry	**Screen**	
New patient	No	enabled	Yes
Last name		enabled	
First name		enabled	
Date of birth	00/00/0000	enabled	
Patient ID		enabled	
Pacemaker	No	enabled	Yes
Gender	-	enabled	female, male
Height		disabled	
Weight		disabled	
Race	unknown	enabled	other
Systole	0 mmHg	disabled	
Diastole	0 mmHg	disabled	
Ordering Physician		enabled	selection from a list of 10 names
Referring Physician		disabled	selection from a list of 10 names
Technician		enabled	selection from a list of 10 names
Telephone	--	enabled	
Medication		disabled	
Comments		disabled	

New patient
yes: existing patient data are deleted
no: entered data can be edited

Date of birth
the slash key must be entered between month/day/year

Patient ID
20 characters maximum

Pacemaker
influences the identification of the pacer pulse in Arrhythmia Mode

Gender/Race
If you do not intend to enter all demographic data, select the neutral entries "-" and "unknown".

Height/Weight
enter the patient's height (in inches) and weight (in pounds)

Systole/Diastole
enter the blood pressure readings in mmHg

Phone
enter the patient's telephone number

Ordering Physician / Referring Physician / Technician
When you choose "yes" for "New patient", the default names entered in the General Settings will appear here. When you choose "other", you can pick a name from the list. It is also possible to choose "no".

You can press to exit the menu.
The "Referring Physician" is only relevant if you send ECGs to the MUSE CV Information System. This name will not be annotated on the ECG recording.

Medication
enter the patients medications and confirm entries with :

Comments
4 lines of 30 characters each

5 Recording in 12 Lead Mode

Tip

Please bear in mind that no automated analysis of ECG signals is completely reliable. Therefore a physician should always overread and reassess the system interpretation before performing patient diagnosis.

5.1 Some Basic Facts

In 12 Lead Mode, 12 leads of ECG are acquired simultaneously for a period of 10 seconds. When initiated with , the acquisition and recording proceed automatically.

Depending on the implemented software options, the ECG

- is only printed out (options MEAS - measurement -, DIAG - interpretation - not implemented)
- is measured and printed out with the measurement results (with option MEAS - measurement)
- is measured, interpreted (analyzed) and printed out with the interpretative statements (with option DIAG - interpretation)

Units equipped with the optional "Memory" function can save up to 40 resting ECG. These ECGs can be

- printed or
- sent to the MUSE CV Information System (CSI protocol) (see section 5.3 "The Memory Function").

The unit offers different report formats for printout of the ECG. With the system defaults, all 12 leads including the measurement and analysis results will be documented on a single page (see section 5.4 "The Report Formats").

Several system settings can be customized. In this manual they are labeled "configurable".

The following information refers to a unit with the system defaults (see table below). For instructions on changing the system setup, refer to section 9.2 "12 Lead Mode".

Parameter	System defaults	Options
Report sequence	STANDARD	CABRERA,
Rhythm leads	II, V1, V5	I, III, aVR, aVL, aVF, V2, V3, V4, V6
Gain	10 mm/mV	"*auto", 5, 20, 40 mm/mV
Report format	4x2.5R1	1x10R12, 2x5R1, 2x5_50, 4x2.5R1, 1x10R3, 4x2.5R3
Detailed results	No	Yes
Muscle filter	No	Yes
Frequency	40 Hz	20 Hz
AC line filter	Yes	No
Manual copy to	EKG	HOST
No. of copies	1	0 to 9
Auto save ECG	No	Yes
Delete ECG after transm.	No	Yes
Use screen. crit.	No	Yes
Suppr. normal st.	No	Yes
Suppr. abnormal st.	No	Yes
No interpretation	No	Yes
Override function	Yes	No

5.2 Recording

On power up, the unit defaults to the 12 Lead Mode (system defaults) (configurable).

– Before recording the ECG, patient data can be entered (pat info). We recommend to enter the patient's name to annotate it on every report.

– After applying the electrodes, please wait about 10 seconds for the signal to stabilize (stabilization of polarization voltages, see section 4.3 "Artifact Due to Poor Electrode Application" in chapter 4). If you initiate a recording with ◇▽ immediately after selection of the 12 Lead Mode, a waiting period of 10 to 12 seconds ensues (message "Collecting data").

– Before initiating a recording, check the display for error messages (see table at left). Check all electrodes; if the message persists, there must be a break in the patient cable. Replace the cable with a new one.

– The MAC 1200 continuously saves 10 seconds of the incoming ECG signal.

When you initiate a recording with ◇▽, the unit prints the most recent 10 seconds of ECG data and analyzes it. Therefore it is recommended to wait until the patient has been lying relaxed and motionless for about 10 seconds before starting the recording.

***RL*:**	***right leg electrode disconnected***
***RA*:**	***right arm electrode disconnected***
***LA*:**	***left arm electrode disconnected***
***LL*:**	***left leg electrode disconnected***
***V1*:**	***chest electrode V1 disconnected***
***V2*:**	***chest electrode V2 disconnected***
***V3*:**	***chest electrode V3 disconnected***
***V4*:**	***chest electrode V4 disconnected***
***V5*:**	***chest electrode V5 disconnected***
***V6*:**	***chest electrode V6 disconnected***

Messages indicating disconnected electrodes

Tip

Please note that filters may suppress diagnostically relevant portions of the signal. Filters should therefore only be enabled if necessary.

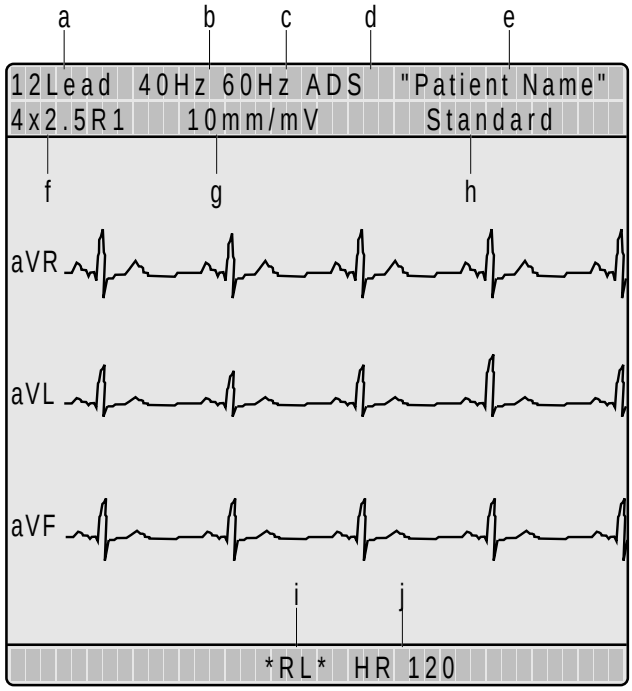


Figure 5-1. 12 Lead mode display

- *a Operating mode*
- *b Muscle filter enabled*
- *c AC line filter enabled*
- *d Anti-drift system enabled*
- *e Patient name*
- *f Report format or "REC OFF" when no recordings are made*
- *g Gain 10 mm/mV (automatic gain adjustment off)*
- *h Report sequence*
- *i Right leg electrode failure message*
- *j Heart rate*

With the system defaults unchanged, the unit will activate the following functions and settings after power-up:

- the 12 Lead Mode (configurable)
- the standard report sequence: I, II, III, aVR, aVL, aVF, VI, V2, V3, V4, V5, V6
- rhythm leads II, V1 and V5 (configurable)
- a gain of 10 mm/mV (configurable) (calibration pulse at the beginning of the recording
- the AC line filter is on (configurable)
- the muscle filter is off (muscle filter) (configurable)
- the anti-drift system (cubic spline) is enabled (wandering baselines are automatically restored to their original position)
- the report format is "4x2.5R1", i.e. 12 leads and all data are printed on one page (configurable)
- the "Detailed results" page (including the median complexes and the ST measurement results) is not printed (configurable)
- pressing copy will print one copy of the ECG (configurable)
- units with MEMO option: all documented ECGs are automatically saved (configurable)
- units with MEMO option: after transfer to a HOST system via the RS232 interface, the ECGs are automatically removed from the MAC 1200 memory (configurable)
- the "Override Function" is enabled (configurable)
- QTC is calculated with the Bazett formula (only with option MEAS (measurement) or DIAG (interpretation))

All relevant device settings are shown on the display (Figure 5-1).

The display shows 3 leads at a time. With lead you can successively display all leads of the report sequence in groups of 3.

- The recording can be stopped with ◇▽.
- For a description of the different reports, refer to section 5.4 "The Report Formats".

Tip

When the unit runs out of paper while printing all stored ECGs (menu item "Print all stored ECGs"), press after inserting a new paper pad. Then print the remaining ECGs successively, or restart a printout of all recordings (Print all ECGs).

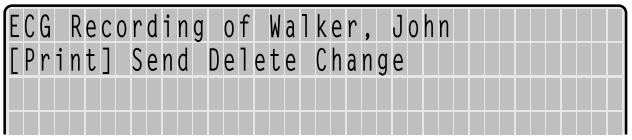


Figure 5-2. ECG identified by patient name

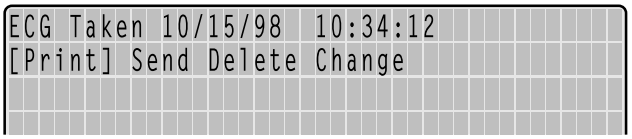


Figure 5-3. ECG identified by recording date and time

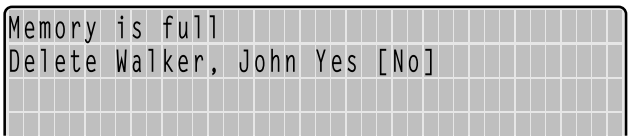


Figure 5-4. "Memory full" message

Tip

When you exit the memory function with , it is not possible to save the current ECG again.

5.3 The Memory Function

Units equipped with the optional MEMO function permit storage of the ECG including patient, measurement and interpretation data with store/retrieve. The display will indicate the number of stored ECGs (40 max.).

To retrieve an ECG from memory, hold down and press store/retrieve.

All stored ECGs can be printed, transferred or deleted (position cursor on appropriate command and confirm with). Use if you wish to select the ECGs individually for printing, transfer, modification and deletion.

Individual ECGs may be accessed by patient name (Figure 5-2). If a name was not entered, the ECG is identified by the recording date and time (Figure 5-3).

If you try to save an ECG when the memory is full, you are informed of the memory status and can remove one of the stored ECGs from memory. Use the cursor keys to select the ECG to be deleted. After discarding the ECG, the unit will automatically save the new data (Figure 5-4).

The unit may be set up to automatically save ECGs (without pressing store/retrieve) and to remove ECGs from memory that were successfully transferred to a host system (MUSE) (see section 9.2 "12 Lead Mode").

The memory program can be terminated at any time with .

5.4 The Report Formats

The length and scope of the reports depends on the implemented software (standard, MEAS (measurement), DIAG (interpretation)).

The table below shows all of the 12 different report formats available with the MAC 1200 units.

Format	ECG traces	Pages	Rhythm lead	Speed	Measurement*	Interpretation*
4x2.5R1 (default format)	4x3	1	1	25 mm/s	yes	yes
4x2.5R3	4x3	1	3	25 mm/s	yes	yes
2x5R1	2x6	1	1	25 mm/s	yes	yes
2x5_50	2x6	2	no	50 mm/s	yes	yes
1x10R12	1x12	1	no	25 mm/s	no	no
1x10R3	1x3	1	3	25 mm/s	yes	yes

* measurement results and interpretative statements are only available from MAC 1200 with the appropriate software options

Caution

The printed reports are unconfirmed documents. They must be overread, verified, and signed by a physician for confirmation.

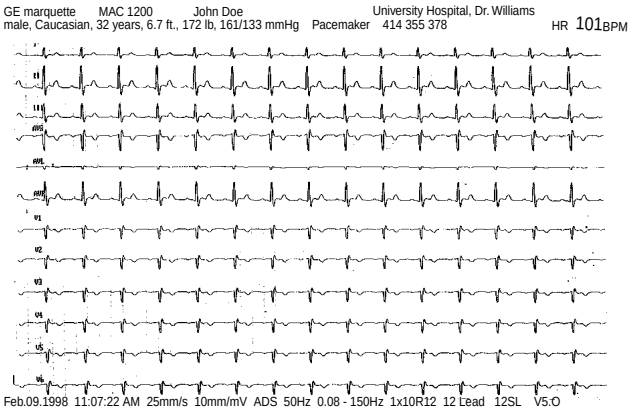

GE marquette MAC 1200 John Doe University Hospital, Dr. Williams
male, Caucasian, 32 years, 6.7 ft., 172 lb, 161/133 mmHg Pacemaker 414 355 378 HR 101BPM
Feb.09.1998 11:07:22 AM 25mm/s 10mm/mV ADS 50Hz 0.08 - 150Hz 1x10R12 12 Lead 12SL V5:O

Figure 5-5. 1x10R12 report format

Detailed results

In the setup menu of units equipped with the MEAS or DIAG option, you can choose the "Detailed results" page. When selected, this page will be appended to the respective report formats. It contains patient data, measurement results (MEAS), interpretative statements (DIAG), medians and the tabular measurement values.

5.5 ECG Transmission via Modem

Warning

Observe the safety information given in section 3.6 "Connecting External Devices".

Resting ECGs acquired in 12 Lead Mode can be transferred to host systems (MUSE CV Information System (version 004A or higher)). The transfer can take place either directly or via modem (RS232 interface). For details on modem setup, please refer to section 3.4 "Connecting External Devices".

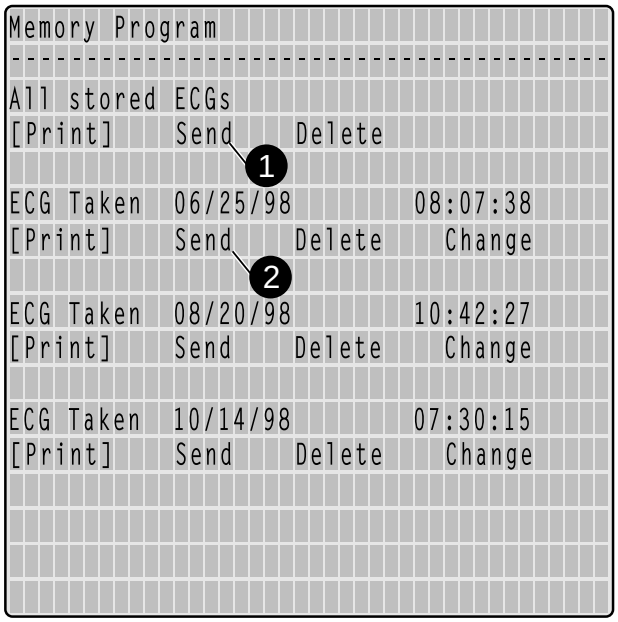


Figure 5-6. Memory program

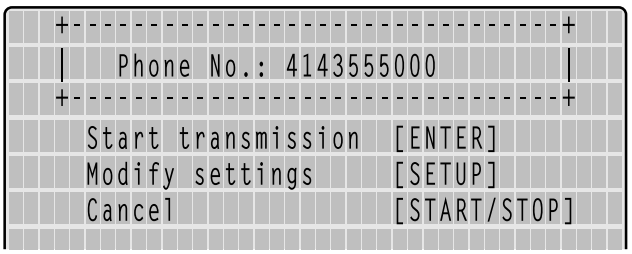


Figure 5-7. Transmission menu

Tip

The MAC 1200 can be set up to automatically store the ECG after acquisition or to automatically delete the stored ECG after transmission.

After acquisition of the ECG, the transmission is initiated with copy (if "Manual copy" is set to HOST in the setup menu - see section 9.2 "12 Lead Mode").

The recorder is also capable of transmitting stored ECGs (if MEMO option is installed). To retrieve ECGs from memory, hold ⇑ down while pressing store/retrieve. You will see the memory menu (Figure 5-6).

- To transfer all stored ECGs, position the cursor on "Send". ("All stored ECGs") (**1**, Figure 5-6), to transfer individual ECGs, position the cursor on "Send" of the respective ECG (e.g. **2**, Figure 5-6).
- Confirm the command with ↵.

You will see the transmission menu as shown in Figure 5-7.

- Check the displayed telephone number and press ↵ to initiate the transfer.
- If it is necessary to change the number, press setup to display the setup menu.
- With ◇▽, the transmission can be stopped.

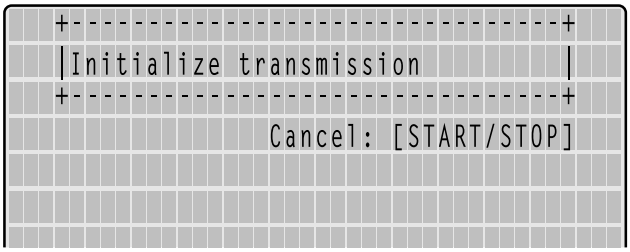


Figure 5-8. Initializing the transmission

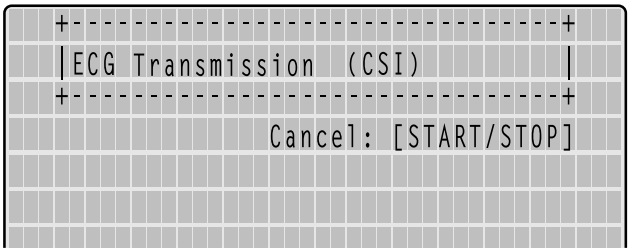


Figure 5-9. Display during ECG transfer

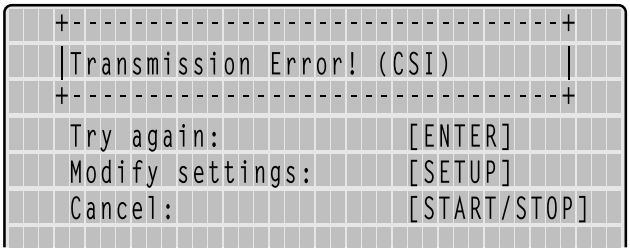


Figure 5-10. Error message

As soon as you initiate the transfer with ↵, the unit will automatically dial the number of the modem at the receiving end and establish a connection (Figure 5-8). Then it will send the ECG (Figure 5-9).

After the transfer, the standard screen display appears again.

If it is not possible to transfer the ECG (wrong modem setup, modem off), the unit will display an error message, such as "Transmission error! (CSI)" (Figure 5-10).

In this situation you have the following choices:

- you can repeat the transmission with ↵
- you can change the settings with setup
- you can stop the transmission with ◇▽.

Modem Error Messages	**Cause**
Transmission Error! (CSI)	The connection was interrupted due to a fault.
Check interface!	Fault in RS232 interface or modem. Modem may be switched off.
No dial tone!	No dialtone detected.
Busy!	Busy signal detected.
No answer!	No answer at remote end.
No carrier!	Carrier signal lost or not detected.
Check modem setup!	Modem configuration error.

5.5.1 Sending Data to a MUSE CV System

Before sending data to the MUSE CV system, the MAC 1200 automatically logs on to MUSE. Then the data will be transferred. If the transfer is stopped, the MAC 1200 may take a few seconds before cancelling the connection because it has to log off the MUSE system first. Then the communication link with the receiving modem is interrupted and the standard display reappears.

5.5.2 Receiving Data with the CSI Communication Protocol

1. Press + copy to enable the "receive data" mode. This will initialize the modem.
2. Press to ready the MAC 1200 for receiving data (the standard screen reappears and you can continue to operate the unit in 12 Lead Mode), or press to disable the "receive data" mode.

While in the "receive data" mode, the unit receives ECG data from the host system either directly or via modem (RS232 interface).

When an ECG has been received, the unit automatically quits the "receive data" mode. After each transfer, this mode must be reenabled with + copy .

The following information is found in the bottom line of each report:

- the sender
- the software version and analysis program version used at the sending unit (e.g. "ACQ-DEV: CSMRT V5.0M12i HEART V4.3).

5.5.3 Cart to Cart Communication

Via modem, ECG data can be transmitted between two MAC 1200 units or between a MAC 1200 and any ECG recorder using the CSI protocol (see sections 5.5.1 and 5.5.2).

5.5.4 Modem Setup (for Modem --> other)

If you prefer to use another modem than the standard models listed in the setup menu (MultiTech, Elsa), you will have to enter a few parameters required for communication between the MAC 1200 and the modem.

For the AT commands which your modem understands, please refer to the modem user instructions. Three command sequences have to be entered in all, each of which defines a specific modem operating state:

1. the modem is initialized (init string)
2. a communication link is established (dial string)
3. the communication is terminated (hangup string)

These three strings are entered in the modem setup menu (see section 3.6 "Connecting External Devices").

The example below shows the command strings for the MultiTech ZDX modem.

1. AT Command for Modem Initialization

AT	prefix that precedes every command line
&F	fetch factory configuration (loads the factory configuration from ROM into the active configuration memory (RAM))
MO	speaker is always off
&DO	ignore DTR status transition
&QI	standard AT result code
VO	digit result codes selected (0 to 999)
-	init string: AT&FMO&DO&:QIVO

2. AT Command for Establishing a Communication Link

Example of a dial string for a modem connected to a branch (PBX system) and dialling a modem via the public telephone network, using the touch tone mode.

AT prefix that precedes every command line

DT touch tone dial mode

xxx after DT, enter the characters for access to the public telephone network (e.g. 0) 0)

W W, placed after a number, tells the modem in a PBX system to wait for the dialtone of an outside telephone line

- dial string: ATDTOW

3. AT Command for Termination of the Communication

The communication is terminated in two steps.

First of all, the MAC 1200 sends an escape command to return from the on-line state to the command state. Then the hangup command follows:

+++ escape command

AT prefix that precedes every command line

H hangup command

- hangup string: +++ATH

5.6 Brief Operating Instructions - 12 Lead Mode

- Switch on the unit and wait for selftest to end
- Apply electrodes to patient
- Enter patient data -

- Check device settings
  - report sequence
  - report format
  - AC line filter
  - override function
  - 12SL interpretation configuration
- Modify device settings, if required -

- Wait for patient to lie motionless and for the unit to collect 10 seconds of ECG data
- Check that no lead failure message is displayed
- Start recording with

6 Recording in 6 Lead Mode

6.1 Some Basic Facts

In 6 Lead Mode, the system acquires 6 leads of ECG in realtime. Recordings are started and stopped with ◇▽. Some of the system settings can be customized. They are labelled with "configurable".

The following information refers to a unit with the system defaults (see table below). For instructions on changing the device setup, refer to section 9.3 "6 Lead Mode".

Parameter	System defaults	Options
Report sequence	STANDARD	CABRERA, SEQ.NO.4
Gain	10 mm/mV	"*auto", 5, 20, 40 mm/mV
Speed	25 mm/s	5, 50 mm/s
Muscle filter	No	Yes
Filter frequ.	40 Hz	20 Hz
AC line filter	Yes	No
Anti-drift system	No	Yes
Start at queue mark	No	Yes

6.2 Recording

After switching on the unit, press to select the 6 Lead Mode.

- Before recording the ECG, patient data can be entered with . We recommend to enter the patient's name to annotate it on each page.

Tip

In 6 Lead Mode, messages indicating disconnected electrodes are annotated on the recording, e.g. Lead fail V1.

– Before initiating a recording, check the display for error messages (see table below). Check all electrodes; if the message persists, there must be a break in the patient cable. Replace the cable with a new one.

RL*:** ***right leg electrode disconnected
RA*:** ***right arm electrode disconnected
LA*:** ***left arm electrode disconnected
LL*:** ***left leg electrode disconnected
V1*:** ***chest electrode V1 disconnected
V2*:** ***chest electrode V2 disconnected
V3*:** ***chest electrode V3 disconnected
V4*:** ***chest electrode V4 disconnected
V5*:** ***chest electrode V5 disconnected
V6*:** ***chest electrode V6 disconnected

Messages indicating disconnected electrodes

Tip

- ***Please note that filters may suppress diagnostically relevant portions of the signal. Filters should therefore only be enabled if necessary.***
- ***Before and during the recording, the second set of 6 leads can be selected with the lead key.***

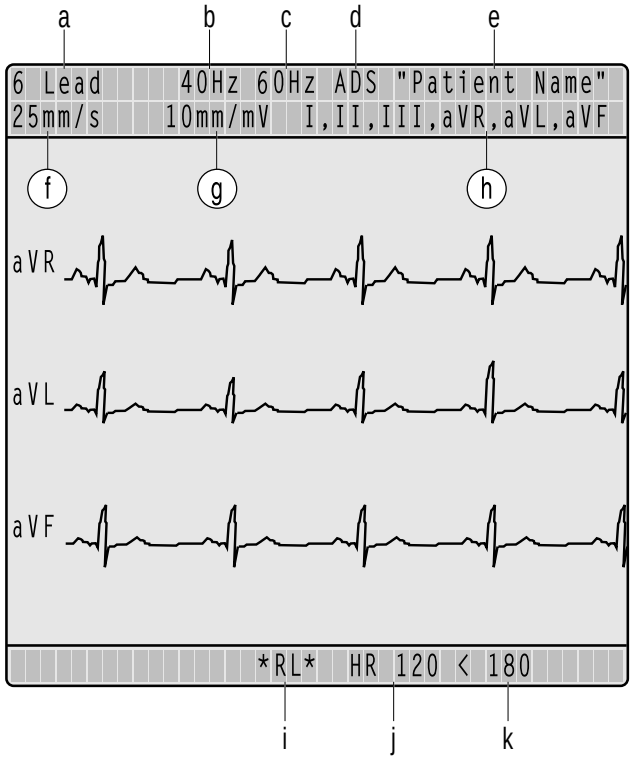


Figure 6-1. 6 Lead mode display

a	*Operating mode*
b	*Muscle filter enabled*
c	*AC line filter enabled*
d	*Anti-drift system enabled*
e	*Patient name*
f	*Writer speed*
g	*Gain 10 mm/mV (automatic gain adjustment off)*
h	*Report sequence*
i	*Right leg electrode failure message*
j	*Heart rate*
k	*Heart rate limit (adjustable)*

– The recording is started and stopped with ◇▽.

With the system defaults, the MAC 1200 will activate the following functions and settings:

– the standard report sequence: I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5, V6, also available: CABRERA, SEQ. NR. 4 (custom report sequence)

– a gain of 10 mm/mV (configurable) (calibration pulse at the beginning of the recording The unit can be set up to automatically adapt the gain to the ECG signal (see section 9.3 "6 Lead Mode"). Also, the gain setting can be changed with gain (5, 10, 20 and 40 mm/mV).

– the AC line filter is enabled

– the muscle filter is disabled

– the anti-drift system (cubic spline) is disabled (configurable)

– the writer prints at a speed of 25 mm/s, the speed can be changed with format/ speed

– Pressing copy will output the patient data after the ECG recording.

– The unit will not advance the paper to the beginning of a new page each time a recording is initiated (configurable)

All relevant device settings are shown on the display (Figure 6-1).

– If you change the writer speed, lead group or any filter settings during a recording, the unit will briefly stop.

– With lead you advance to the next group of 6 leads of the selected report sequence.

– With ↓ / ↑. you toggle between the two lead sets (3 each) on the display that belong to the recorded group.

– When the anti-drift system is enabled, there will be a short delay before the recording starts. The ECG will then be recorded with a delay of 2.2 s.

The heart rate limit is automatically calculated from the date of birth (WHO 100% = 220 - age). When the date of birth is not entered, the unit will set the limit at 180 bpm. This value can be changed with F- and G+ (in steps of 5 bpm). The minimum value for the heart rate limit is 30 bpm.

6.3 Brief Operating Instructions - 6 Lead Mode

- Switch on the unit and wait for selftest to end
- Apply electrodes to patient
- Select the 6 Lead Mode -
- Enter patient data - pat info
- Check device settings
  - report sequence
  - AC line filter
  - ADS (cubic spline)
  - heart rate alarm limits
- Modify device settings, if required - setup
- Watch ECG on display
- Check that no lead failure message is displayed
- Start recording with ◇▽
- Proceed to the next group of 6 leads with lead
- Change the writer speed with format/ speed
- Switch on muscle filter with muscle filter
- Stop the recording with ◇▽
- Print patient data with copy

7 Arrhythmia Mode

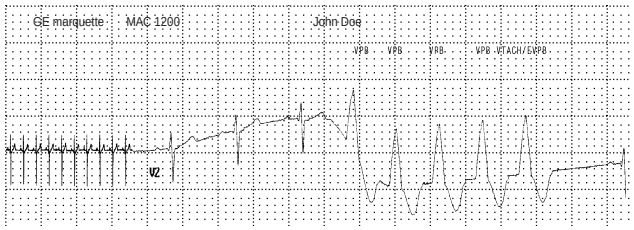


Figure 7-1. Event recording

Tip

After starting the program, press format/speed to select a continuous recording with a speed of 5 mm/s (configurable). If the unit identifies an arrhythmic event, it will automatically switch to the fast paper speed. With the same key format/speed, the trend recording can be stopped. The unit can be set up to automatically start a trend recording when the Arrhythmia Mode is initiated.

Parameter	System defaults	Options
Report sequence	STD_CH (chest leads V1 through V6)	STD_RED (I, II, III, V2, V4, V6) STD_LI, (I, II, III, aVR, aVL, aVF) CABR_LI (aVL, I, -aVR, II, aVF, III) SEQ. No. 6 (V1' through V6')
Gain	10 mm/mV	"*auto", 5, 20, 40 mm/mV
Muscle filter	No	Yes
Frequency	40 Hz	20 Hz
AC line filter	Yes	No
Trend rec.	No	Yes
Arrhythmia data	unequal	all, no
Patient ID sheet	Yes	No
Arrhythmia report	Yes	No
Episodes	chron.	prio, ventr., no

7.1 Some Basic Facts

In Arrhythmia Mode, the MAC 1200 continuously scans the ECG for arrhythmias.

From six simultaneously acquired leads, the MAC 1200 automatically selects the two that provide the best signal for analysis.

When the analysis algorithm detects an arrhythmia, the event is recorded with "context" (Figure 7-1). The length of the recording varies with the duration of the event episode. In the setup menu (section 9.4 "Arrhythmia Mode") you determine the conditions for a recording:

- the recorder starts each time it detects a single-beat event - all
- the recorder starts each time it detects an event different from the previous event - unequal
- the recorder does not start at all - no.

Some of the system settings can be customized. They are labeled with "configurable". The following information refers to a unit with the system defaults (see table at left). For instructions on changing the system setup, refer to section 9.4 "Arrhythmia Mode".

7.2 Recording

- After switching on the unit, press arrhy to select the Arrhythmia Mode.
- Before recording the ECG, patient data can be entered (pat info). We recommend to enter the patient's name to annotate it on each page.
- Before initiating a recording, check the display for error messages (see table at left). Check all electrodes; if the message persists, there must be a break in the patient cable. Replace the cable with a new one.
- The recording is started and stopped with the ◇/▽ key.

Upon program start, the unit records 6 leads of ECG (1 page). During the following learn phase, the analysis algorithm learns the patient's typical QRS complex. After the learn phase, the recorder prints a report where the QRS complexes acquired in the learn phase are labelled "L" and the complex found to be the patient's typical complex is labelled "QRSL". Having completed the learn phase, the MAC 1200 is ready to identify arrhythmias.

With the system defaults, the MAC 1200 will activate the following functions and settings:

- the STD_CH report sequence V1 through V6 (configurable)
- a gain of 10 mm/mV (configurable) (calibration pulse at the beginning of the recording The unit can be set up to automatically adapt the gain to the ECG signal (*auto)
- the AC line filter is enabled (configurable)
- the muscle filter is disabled (configurable)

***RL*:**	***right leg electrode disconnected***
***RA*:**	***right arm electrode disconnected***
***LA*:**	***left arm electrode disconnected***
***LL*:**	***left leg electrode disconnected***
***V1*:**	***chest electrode V1 disconnected***
***V2*:**	***chest electrode V2 disconnected***
***V3*:**	***chest electrode V3 disconnected***
***V4*:**	***chest electrode V4 disconnected***
***V5*:**	***chest electrode V5 disconnected***
***V6*:**	***chest electrode V6 disconnected***

Messages indicating disconnected electrodes

Tip

With copy, a single-page recording can be initiated after program start.

Tip

Please note that filters may suppress diagnostically relevant portions of the signal.
Filters should therefore only be enabled if necessary.

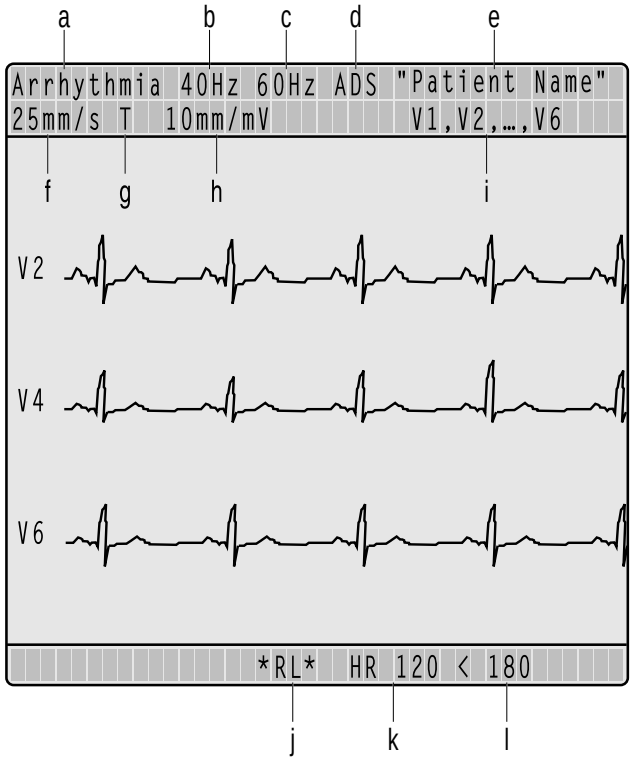


Figure 7-2. Arrhythmia mode display

- *a Operating mode*
- *b Muscle filter enabled*
- *c AC line filter enabled*
- *d Anti-drift system enabled*
- *e Patient name*
- *f Writer speed (event episodes)*
- *g Trending enabled*
- *h Gain*
- *i Report sequence*
- *j Right leg electrode failure message*
- *k Heart rate*
- *l Heart rate limit*

Tip

The letter A on a recording indicates the presence of artifact which does not allow the algorithm to identify arrhythmias. Causes include wandering baselines. The anti-drift system largely prevents these disturbances. Still you should checke the electrodes and leadwires.

- the anti-drift system is enabled
- the automatic baseline adjustment is enabled
- the slow trend recording is disabled (configurable)
- event episodes are recorded at a speed of 25 mm/s
- the unit documents all events that are different from the previous event (configurable). You can set up the unit to document all events or no event at all.

All relevant device settings are shown on the display (Figure 7-2).

The arrhythmia codes annotated on the recording are explained in table 7-1 (next page).

The heart rate limit is automatically calculated from the date of birth (WHO 100% = 220 - age). When the date of birth is not entered, the unit will set the limit at 180 bpm. This value can be changed with F- and G+ (in steps of 5 bpm). The minimum value for the heart rate limit is 30 bpm.

Arrhythmic Events	
– asystole, limit value	ASYSTO
– ventricular fibrillation/flutter	VFIB
– ventricular tachycardia (>3 VPBs)	VTAC
– ventricular run (3 VPBs)	RUN
– ventricular couplet (2 VPBs)	CPLT
– pause of 2 missed beats	PAU2
– pause of 1 missed beat	PAU1
– early VPB	EVPB
– ventricular bigeminy	VBIG
– new form (e.g. intermittent bundle branch block)	NF
– multiform VPBs	MULT
– supraventricular arrhythmia	SVAR
– paroxysmal supraventricular tachycardia	PSVT
– tachycardia	TACH
– bradycardia	BRAD
– pacemaker malfunction	PERR
– ventricular escape beat	ESC
– ventricular premature beat	VPB
– supraventricular premature beat	SVPB
– aberrant beat	ABR
– pacemaker capture	PCAP
– pause (>l.5 times the normal RR interval)	TL
– absolute pause, limit value	PAUA
– artifact	A
– learn phase	L
– learned QRS complex	QRSL

Table 7-1. Arrhythmia codes

7.3 Brief Operating Instructions - Arrhythmia Mode

- Switch on the unit and wait for selftest to end
- Apply electrodes to patient
- Select the Arrhythmia Mode - arrhy
- Enter patient data - pat info
- Check device settings
  - report sequence
  - AC line filter
  - trend recordings
  - arrhythmia report
  - patient ID sheet
  - episode report
  - heart rate alarm limits
- Modify device settings, if required - setup
- Check that no lead failure message is displayed
- Start recording with ◇▽
- Switch on muscle filter with muscle filter
- Stop the recording with ◇▽
- Print patient data with copy

8 ECGs of Pacemaker Patients / ECG Recording during Defibrillation

Recording ECGs of Pacemaker Patients

Due to the slow paper speed it is not possible to display pacer pulses directly on the ECG recording. At a paper speed of 50 mm/s and a pulse duration of 0.5 ms, the width of the recorded pacer pulse would be only 0.025 mm.

For this reason the recorder reduces the pulse amplitude and expands the pulse width, so that the pacer pulse is easier to identify. The MAC 1200 records the pulse with the correct polarity, with a width of 5 ms and with the same amplitude in all leads (depending on the polarity of the pacer pulse in leads I and II, the pacer pulse in lead III may be suppressed). The amplitude of the reverse current may differ from lead to lead. Figure 8-1 shows an ECG recording with pacer pulses.

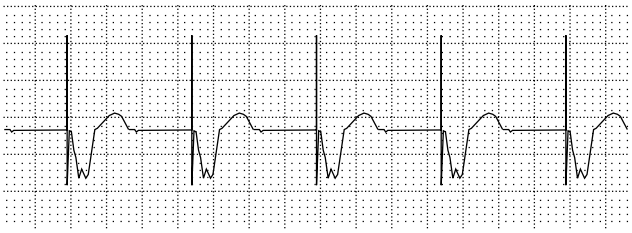


Figure 8-1. ECG recording with pacer pulses

Warning

If several adverse conditions exist at once, the possibility that the pacer pulses are interpreted (and counted) as QRS complexes should be considered. At the same time, however, QRS complexes might be suppressed in certain situations. Therefore, pacemaker patients should always be watched closely.

ECG Recording During Defibrillation

The patient signal input is defibrillation-proof so it is not necessary to remove the ECG electrodes before defibrillating the patient.
However, when using stainless steel or silver electrodes, the defibrillator discharge current may cause complete polarization at the electrode/skin interface. This condition may prevent ECG signal acquisition for several minutes. With silver/silver chloride electrodes, this will not happen.

Set the MAC 1200 to 6 Lead Mode when you may have to defibrillate the patient while recording the ECG, and disable the anti-drift system as this would cause a 2 second signal delay (section 9.3 "6 Lead Mode").

If electrodes made of other materials are used, disconnect the patient cable from the recorder while the shock is applied.

Warning

- ***For reasons of patient safety, use only the original Marquette patient cable. Before connecting the cable to the device, check it for signs of mechanical damage. Do not use a damaged cable.***
- ***Use silver/silver chloride electrodes for ECG signal acquisition, if the patient may have to be defibrillated.***
- ***The patient signal input of the recorder is protected against damage resulting from defibrillation shocks. Nevertheless, extreme care should be exercised when defibrillators are used on a patient connected to other devices while a shock is released.***
- ***Observe the safety information of the defibrillator.***
- ***During defibrillation, do not touch the patient, the electrodes or the leadwires.***

9 System Setup

9.1 Some Basic Facts

- Press setup to display the setup menu.

The main menu with the following options will appear:
- Operating mode: 12 Lead (6 Lead, Arrhythmia)
- General Settings
- Communication
- Setup Patient Data
- Option Code

At "Operating mode", you will always see the currently selected mode. So be sure to select the appropriate mode before entering the setup menu.

- To access the menu options, position the bar cursor on the option with the cursor keys and confirm the selection with ↵.

The operating steps to select a setting are always the same:

- Using the cursor keys ← and →, you select the option, then you confirm the selection with ↵.

The cursor will move to the next menu item.

- Individual items can be skipped with ↓ or ↑.
- Press ◇ ▽ to exit the setup mode.

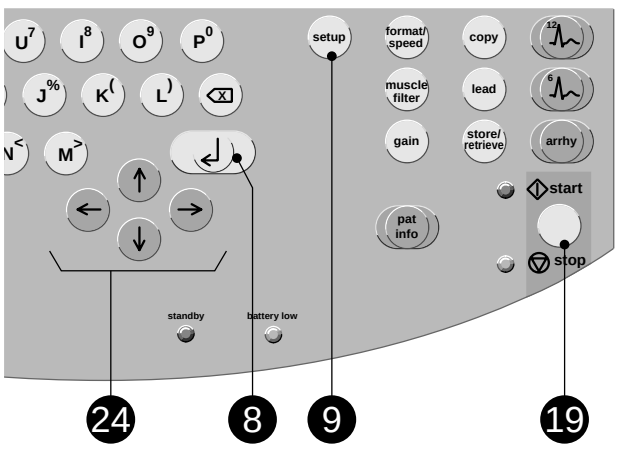


Figure 9-1. System setup keys

9.2 12 Lead Mode

- Use the cursor keys to position the bar cursor on "12 Lead" and confirm the selection with ↵.

The setup menu for automatic 12 lead recording will appear.
The angular brackets [ ] denote the system defaults.

Report sequence

[STANDARD] (I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5, V6)
CABRERA (aVL, I, -aVR, II, aVF, III, V1, V2, V3, V4, V5, V6)

Rhythm leads

Any three of the available ECG leads can be selected as rhythm leads. They are printed with report formats 4x2.5R3 and 1x10R3. Formats 2x5R1 and 4x2.5R1 will show only the first of the rhythm leads.

Gain

5, [10], 20, 40 mm/mV, *auto

Report format

For an overview of the available report formats, refer to section 5.4 "The Report Formats". The default format is 4x2.5R1.

Detailed results

The "Detailed results" page will be printed, yes/[no] (section 5.4 "The Report Formats", only available with option MEAS or DIAG).

Muscle filter/AC line filter

Elimination of muscle artifact and AC line interference.
Default: muscle filter [No], AC line filter [Yes]

> **Tip**
>
> ***Please note that filters may suppress diagnostically relevant portions of the signal. Filters should therefore only be enabled if necessary.***

Filter frequency

Cut-off frequency of the muscle filter ([40 Hz], 20 Hz).
The frequency range is indicated in the lower margin of the recording strip.
"0.08 - 40 Hz" (40-Hz muscle filter enabled)
"0.08 - 20 Hz" (20-Hz muscle filter enabled)
"0.08 - 150 Hz" (muscle filter off).

Manual copy to

When the copy key is pressed, the unit will print a copy of the ECG [EKG] or send the ECG to a HOST system (MUSE CV Information System).

No. of copies

If you do not want to print the ECG, but only collect data, select "0" (message on display "REC OFF"). When a number greater than 1 is selected, multiple copies of the reports will be printed. Default: [1]

Autosave ECG (only with "Memory" option)

After report generation, the ECG will or will not be automatically saved to the internal memory (yes, [no]).

Delete ECG after Transmission (only with "Memory" option)

ECGs that were successfully sent to a HOST system via the RS232 interface will be cleared from the recorder memory (yes, [no]).

Configuration of the 12SL Interpretation

Use screening criteria

The screening criteria can be enabled or disabled.
Default: [disabled]

Suppress "normal" statement

If you select 'Yes', the interpretation statement "normal ECG" will not be shown.

Suppress "abnormal" statement

If you select 'Yes', the interpretation statement "abnormal ECG" will not be shown.

No interpretation

If you select 'Yes', no results of the 12 SL interpretation will be shown.

Override function

When this function is enabled [yes], the recorder will print in 12 Lead Mode, even when not all electrodes are applied or do not supply a good signal.
When electrodes are disconnected, a message informing the user of poor signal quality will be printed on the recording.

Furthermore, systems with interpretation capability will print a message indicating that the measurement results and interpretation may be incorrect.

9.3 6 Lead Mode

- Use the cursor keys to position the bar cursor on "6 Lead" and confirm the selection with ↵.

The setup menu for continuous recording of 6 leads will appear.

Report sequence

1. [STANDARD] (l, II, III, aVR, aVL, aVF, VI, V2, V3, V4, V5, V6)
2. CABRERA (aVL, l, -aVR, II, aVF, III, VI, V2, V3, V4, V5, V6)
3. SEQ. NO. 4 (here, users can define a custom report sequence):

- Position the cursor on "SEQ. NO. 4".
- Press setup.

The display shown in Figure 9-2 will appear.

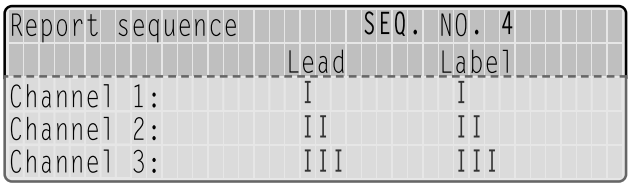


Figure 9-2. Creating a custom report sequence

- Press ↓.

The cursor will move to the position for entry of the lead in channel 1. Follow these steps, if you wish to record aVR in channel 1, for instance:

- Enter AVR and confirm the entry with ↵.

The cursor moves to the position for entry of the lead designation. AVR appears there as well.

- If you wish to enter another designation, you can overwrite the default name (4 characters max.).
- Confirm your entry with ↵ and repeat the above steps for channel 2, etc.

You can write over "SEQ. NO. 4" if you wish to enter another name for the report sequence.

Gain

*auto, 5, [10], 20, 40 mm/mV; with "*auto", the unit will automatically determine the appropriate gain setting for the 6 simultaneous leads.

Speed

Changes the writer speed. Default: [25 mm/s]

Muscle filter/AC line filter

Elimination of muscle artifact and AC line interference
Default: muscle filter [No], AC line filter [Yes]

Filter frequency

Cut-off frequency of the muscle filter ([40 Hz], 20 Hz).
The frequency range is indicated in the lower margin of the recording strip.
"0.08 - 40 Hz" (40-Hz muscle filter enabled)
"0.08 - 20 Hz" (20-Hz muscle filter enabled)
"0.08 - 150 Hz" (muscle filter off).

Anti-drift system (ADS) (cubic spline)

In case of wandering baselines, the anti-drift system restores the baseline to its original position (signal delay with ADS approx. 2 s). Default: [No]

Start at queue mark

Before each recording, the recorder advances the paper to the beginning of a new page (yes, [no]).

9.4 Arrhythmia Mode

- Use the cursor keys to position the bar cursor on "Arrhythmia" and confirm the selection with .

The arrhythmia mode menu will appear.

Report sequence

[STD_CH]: V1, V2, V3, V4, V5, V6
STD_RED: I, II, III, V2, V4, V6
STD_LI: I, II, III, aVR, aVL, aVF
CABR_LI: aVL, I, -aVR, II, aVF, III
SEQ NO. 6: V1', V2', V3', V4', V5', V6'
(CH = chest leads, RED = reduced number of leads, LI = limb leads)

Gain

*auto, 5, [10], 20, 40 mm/mV; with "*auto", the unit will automatically determine the gain setting.

Muscle filter/AC line filter

Elimination of muscle artifact and AC line interference
Default: muscle filter [No], AC line filter [Yes]

Filter frequency

Cut-off frequency of the muscle filter ([40 Hz], 20 Hz).
The frequency range is indicated in the lower margin of the recording strip.
"0.08 - 40 Hz" (40-Hz muscle filter enabled)
"0.08 - 20 Hz" (20-Hz muscle filter enabled)
"0.08 -100 Hz" (muscle filter off).

Trend rec.

The slow trend recording of 5 mm/s automatically begins at program start ([no]/yes).

Arrhythmia data

The recorder will document arrhythmias in the following situations:

- each time an arrhythmia occurs
- each time an arrhythmia occurs that is different from the preceding event
- arrhythmias are not documented

all, [unequal], no.

Patient ID sheet

Patient ID sheet included in report ([yes], no).

Arrhythmia report

Final report includes arrhythmic events in tabular format: [yes], no.

Episodes

Final report includes episode report, with episodes listed by one of the following criteria

- in chronological order
- according to priorities (see table 7-1)
- ventricular beats only
- no episode report

[chron.], prio., ventr., no

9.5 General Device Settings

Ordering Physician / Referring Physician / Technician

In the field at left, you see the last name of the physician or technician selected as the default name. When selecting "other", a menu displays where you can enter up to 10 names (2-digit ID number, first name, last name). The default name (and ID) is automatically selected at power-up.
The "Referring Physician" is only relevant if you send ECGs to the MUSE CV system. This name will not be annotated on the ECG recording. Press the key to exit the menu.

Institution Name

The name entered here will be printed on each report page.

Date/Time

Enter date and time (enter 4 digits for the year).

Lead fail beep

Indicates when electrodes are not properly applied or disconnected (yes/[no]).

High HR beep

An audible signal sounds when the heart rate exceeds a limit value (yes/[no]) (only in 6 Lead and Arrhythmia Modes). The limit value (220 - age) can be changed manually.

Lead labels

[AAMI] codes: RA, LA, RL, LL, V1 to V6 or
IEC codes: R, L, F, N, C1 to C6

Date

Format: [month/day/year] or day.month.year

Time

Time format [12] hours (am/pm) or 24 hours

Units

Units of measurement for the patient's height and weight: [in/lb] or cm/kg

Mains

AC line frequency (USA [60 Hz], Europe 50 Hz)

LCD light off after

If operating controls are not activated within the selected period of time the display backlighting automatically switches off (system default [5 min], adjustment range l to 99 min).

Default mode

This is the operating mode the unit defaults to after power-up: [12 Lead], 6 Lead, Arrhythmia

Test DATA

Used for demonstration purposes (yes). It must be set to [no] for proper clinical use.

System setup

Selecting "Yes" will restore the default setup (including the defaults of the three operating modes).
The electrocardiograph must be switched off (standby) and on again for the new settings to become effective.

Print Setup Lists

Selecting "yes" will display a menu with all available setup lists.
- all lists
- General Settings / Communication / External Devices / Patient Data Setup
- 12 Lead
- 6 Lead
- Arrhythmia

Language

Select the language for user interface and printouts.

9.6 Communication

Protocol

The recorder offers two communication protocols: "CSI" (**C**lient **S**erver **I**nterface) and "A5".

The [CSI] protocol supports the transfer of resting ECGs from the MAC 1200 to the MUSE CV Information System.

Location (only with "CSI" protocol)

ID number of the sending system (4 digits).
Default: 1; options: 1 to 9999

Site (only with "CSI" protocol)

ID number of the MUSE CV Information System (2 digits).
Default: 1; options: 1 to 99

Baud rate (HOST)

Transmission rate for the selected protocol. We recommend the default setting of [19200] baud.
Options: 9600, 38400

Modem

Select the modem type. You can choose among the standard modems MultiTech (MT 19.32, 56.6), Elsa 14.4, Elsa 28.8, Elsa 33.6 and a user-defined modem.

When using one of the standard modems, all you have to enter is

- the dial mode (pulse or tone, depending on your telephone network)
- the telephone number (28 digits max.)
- outside line (enter the digit for access to the public telephone network, e.g. "0").

For a user-defined modem, enter

- the telephone number (28 digits max.)
- the init string (20 characters max.) (see modem operator's manual)
- the dial string (20 characters max.) (see modem operator's manual)
- the hangup mode (20 characters max.) (see modem operator's manual)

9.7 Patient Data

The patient data menu can be set up to meet individual requirements. If you do not want to enter blood pressure readings, for instance, you can remove the corresponding prompts:

- Use the cursor keys to position the bar cursor on "Setup Patient Data" and confirm the selection with ↵.

The patient data setup menu will appear.

- Select "no" for prompts that you want to remove from the dialog.

Items
- Last name
- First name
- Date of birth
- Patient ID

cannot be removed.

Items
- Height
- Weight
- Diastole
- Systole
- Referring Physician
- Medication

are disabled. They can be enabled from the patient data setup menu.

- Press ◇▽ to exit the menu.

9.8 Option Code

In this menu you enter the option codes to enable a number of optional software functions. The respective option becomes active after you have entered the code number. The code numbers are listed on the option code sheet of the different software options.

How to activate options

- Press setup to display the setup menu.

The main menu appears, showing the following items:
- Operating mode: 12 Lead (6 Lead, Arrhythmia)
- General Settings
- Communication
- Setup Patient Data
- Option Code

- Using the cursor keys, position the bar cursor on Option Code and confirm the selection with ↵.

The option code menu appears.

- Enter the 12-digit code number from the keyboard and exit the menu with ◇▽.
- Use the cursor keys to position the bar cursor on "Option code" and confirm the selection with ↵

The option code menu will appear.

MEAS: measurement of the 10-second resting ECG

DIAG: measurement and interpretation of the 10-second resting ECG

MEMO: program for storage of up to 40 resting ECGs

C100: activates the three options MEAS, DIAG, MEMO for a maximum of 100 ECGs

C500: activates the three options MEAS, DIAG, MEMO for a maximum of 500 ECGs

EVAL: activates the three options MEAS, DIAG, MEMO for a maximum of 4 weeks

- Enter the code number and exit the menu with ◇▽.

10 Loading Chart Paper

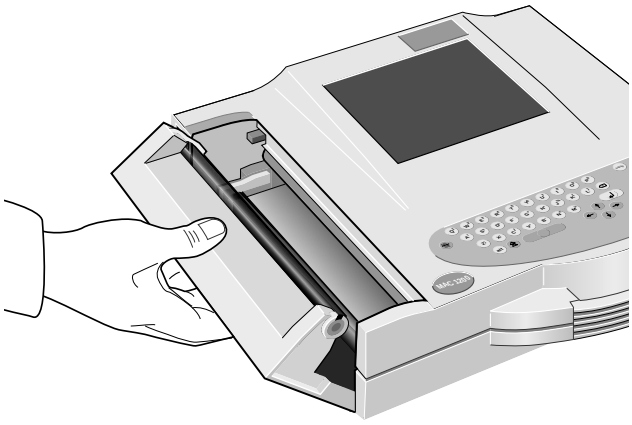


Figure 10-1. Opening the paper compartment door

- Switch on the recorder.
- Pull up the handle of the paper door and fold it out (Figure 10-1).
- Remove the cardboard backing of the previous paper pad.

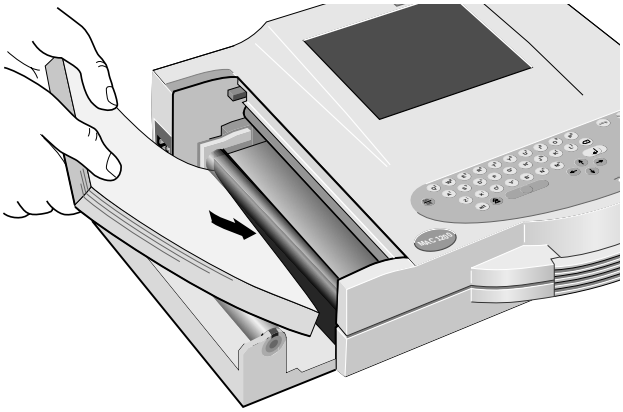


Figure 10-2. Inserting the new Z-fold pad

- Remove the cardboard from the top of the new pad and place the pad, including the cardboard backing at the bottom and with the arrow pointing towards the unit, into the paper compartment (Figure 10-2).

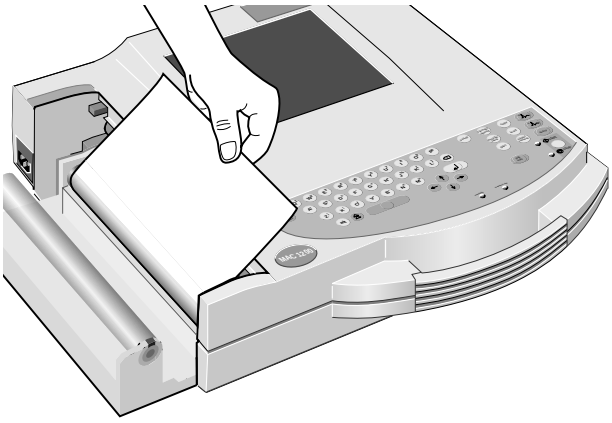


Figure 10-3. Guiding the leading paper edge over the guide roller

- Pull the top sheet out of the compartment and guide it around the guide roller (Figure 10-3).

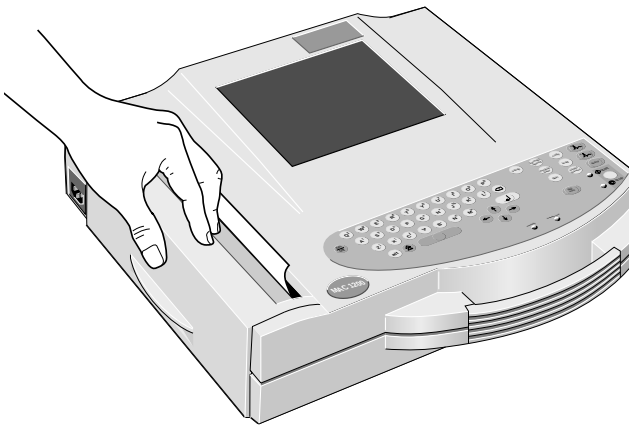


Figure 10-4. Closing the paper compartment door

- Holding the leading edge of the paper in place between the two markers on the recorder, close the paper door (Figure 10-4). Ensure that it locks into place on both sides.

When inserting an already started Z-fold pad, the grid side must face up and the first fold must point towards the paper compartment.

End-of-Paper Indication

A stripe marks the last 10 pages of the Z-fold pad.

Tip

– ***If you store the recordings in plastic folders these should be made of polyethylene, because the traces fade in PVC covers (if in doubt, insert a sheet of paper between recording and folder).***

– ***When closing the paper door, take care that it locks into place on both sides.***

– ***There is a window in the paper door that allows you to look inside the compartment and check the paper supply.***

– ***Use only the original Marquette CONTRAST chart paper or the Marquette thermal paper with queue marks or holes. This paper has a special coating that prevents***
  - ***contamination and debris collecting on the printhead and***
  - ***electrostatic build up.***

- ***Furthermore, the thermosensitive layer and the printhead characteristics are exactly matched. Using other paper may result in recordings of poor quality.***
  Moreover, the printhead may wear out prematurely. Use of other paper voids the warranty.

11 Cleaning, Disinfection and Maintenance

11.1 Cleaning and Disinfecting the Recorder Housing

Warning

Before cleaning or disinfecting the device, disconnect it from the power line.

- Clean the recorder housing with a moist cloth. Do not let liquid enter the device. All cleaning agents and disinfectants that contain alcohol and are commonly used in hospitals are suitable, but do not use disinfectants on a phenol base or peroxide compounds.

11.2 Cleaning and Disinfecting the Patient Cable

- Disconnect the cable from the recorder before cleaning or disinfecting it. When disconnecting the cable, be sure to pull on the connector, not on the cable.
- **Clean** the cable by rubbing it down with a cloth moistened with soap water. Use a disinfectant for **disinfection**. Do not immerse the cable in liquid.

11.3 Cleaning and Disinfecting the Electrodes

In addition to the information given in this manual, observe the instructions for use of the respective electrode types.

- Discard disposable adhesive electrodes immediately after use to prevent that they are reused.
- Clean reusable electrodes immediately after removing them from the patient.
- Peel off the adhesive foil before cleaning the electrodes (rests of the adhesive can be removed with benzine).
- Then use warm water and a small brush to clean the electrodes of cream or gel. Do not use pointed or sharp objects for cleaning.
- Disinfect the electrodes with alcohol-free disinfectant. Ensure that connectors and sockets do not become wet.
- The only approved sterilization method is gas sterilization.
  Frequently sterilizing the electrodes with ethylene oxide gas reduces the life of the plastic material.

11.4 Maintenance

Checks before each use

Before each use, visually inspect the device, the leads and electrodes for signs of mechanical damage.

If you detect damages or impaired functions that may adversely affect the safety of the patient or user, do not use the device before it has been repaired.

Technical Inspections

For safety, the devices require regular maintenance. To ensure functional and operational safety of the MAC 1200 units, Technical Inspections should be carried out on an annual basis.

These checks should be performed by persons with adequate training and experience.

The checks can be carried out by Marquette within the framework of a service contract. The inspections include the following checks:

- Visually inspect the device and the accessories for signs of mechanical damage that may impair the device functions.
- Check that the device labelling relevant for safety is legible.
- Run a performance test as described in the operator's manual.
- Measure the resistance of the protective earth conductor and the equivalent leakage current per your national regulations.

The device does not require any other maintenance.

12 Troubleshooting

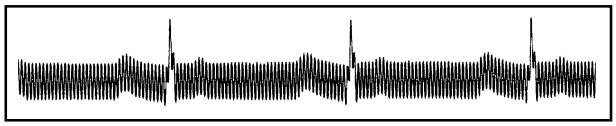


Figure 12-1. Regular AC line interference

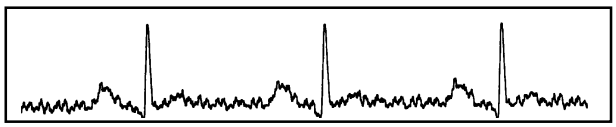


Figure 12-2. Irregular AC interference

Symptom: Regular AC line interference (60 Hz).

Cause: interference from the power line

Remedy Ground stretcher, verify position of the leadwires.
Switch on the AC line filter, if necessary.

Symptom: Irregular interference signals

Cause: Muscle artifact caused by patient movements, hiccup, coughing

Remedy: The patient should be warm enough and resting comfortably (place cushions under arms and knees).
Comfort patient or distract patient's attention.
Enable muscle filter (20 Hz / 40 Hz), if necessary.

Symptom: The printed date and time are incorrect.

Cause: Built-in lithium battery is depleted. The battery has a life of approx. 5 years.

Remedy: Have battery checked and replaced by the Marquette service.

Symptom: The green **standby** indicator **23** does not light up, although the unit is connected to the power line

Cause: Defective AC power cord or fuse.

Remedy: Notify service.

Symptom: The recorder does not write over the entire paper width.

Cause: Paper compartment not properly closed.

Remedy: Paper door must lock into place on both sides.

Symptom: In 12 Lead Mode, the recorder does not stop and continues to feed paper. This does not happen in 6 Lead Mode.

Cause: The paper pad was inserted the wrong way round so the recorder cannot detect the queue mark.

Remedy: Insert the paper pad as instructed.

Symptom: Recorder does not start after activation of the key, or the recording is aborted.

Cause: Recorder operating on battery power, battery depleted.

Remedy: Connect recorder to the power line. After a few minutes, the recorder is able to resume operation. Always connect recorder to the power line when the **battery low** indicator **22** lights up. The battery capacity depends on age, temperature and charge level (chapter 3 "Putting the Device into Operation").

Symptom: No recording in 12 Lead Mode

Cause: At least one electrode is off the patient.

Remedy: Check all electrodes or enable Override function (section 9.2 "12 Lead Mode").

13 Technical Specifications

Recording

Direct recording of waveforms and alphanumeric characters with rectangular coordinates by means of thermal-array printhead printing on thermosensitive paper.

- 3 or 6 recording channels, or 12 in 12 Lead Mode, overlapping
- baseline pitch 3 channels: 62 mm (arrhythmia)
  6 channels: 31 mm (6 Lead)
  12 channels: 16 mm (12 Lead.)
- writing width 200 mm max.
- annotation of recorder settings, date, time and entered patient name in the margin of the recording strip
- with appropriate software, documentation of analysis results in the respective operating mode
- resolution of the recording:
  vertical 8 dots/mm
  horizontal 25 µm at 25 mm/s

Printer paper

Marquette CONTRAST Z-fold pad , 150 pages per pad, equivalent to a chart length of approx. 45 m

paper width: 8.5 inch

sheet length: 11 inch

To prevent damage to the printhead use only the original Marquette CONTRAST paper or the Marquette thermal paper with queue holes or marks.

Paper transport

- paper speed
  5-25-50 mm/s, key selectable
  error limits at 25 and 50 mm/s, typ. ±l%
  at 5 mm/s, ±10% max.
- At paper end, the recorder emits an audio signal and stops recording
  the last pages of the pad bear a colored stripe in the lower margin

Membrane keypad

Pushbuttons with tactile feedback

- function keys for all routine operations
- alphanumeric keyboard for entry of text

Display

graphics display with 24 x 40 characaters, contrast adjustment

resolution of 320 x 240 pixels with display backlighting

Indicators (LEDs)

For mains power, battery status and start/stop function

Automatic functions

They assist and facilitate operation by

- automatic control of lead selection, paper feed, calibration (configurable)
- report formatting (configurable)
- automatic baseline adjustment
- anti-drift system (cubic spline) compensating for polarization voltage fluctuations (configurable)

Detection of pacer pulses

- pulse length between 0.1 and 2.5 ms
- pacer pulse marker independent of pulse polarity
- pulse amplitude between ± 5 mV and ± 700 mV

Heart rate indication

derivation of the heart rate from all ECG signals

- display range between 30 and 300 bpm
- display update with every heart beat, maximum every 2 seconds

Signal inputs

isolated patient signal input, IEC type CF, high-voltage protection for all lead connections and neutral electrode, interference compensation via neutral electrode, monitoring for open leads

- electrode connections for RA, LA, LL, LA, Vl to V6
- input impedance for differential signals between any two electrode connections > 10 MΩ at 10 Hz
- input impedance for common-mode signals referred to neutral electrode > 50 MΩ up to 60 Hz
- dynamic range for differential signals between any two electrode connections for AC voltage ±10 mV, for superimposed DC voltage (polarization voltage) ±600 mV
- dynamic range for common-mode signals referred to neutral electrode ±l V, referred to chassis 263 V AC (rms)
- quiescent input current via any electrode connection for l kΩ termination referred to neutral electrode < 50 nA
- patient leakage current (rms values) according to IEC, class CF: in normal condition < 10 µA, in single-fault condition (e.g. patient in contact with line voltage) < 20 µA
- non-destructive range for lead-electrode connections and the neutral electrode connection referred to neutral electrode ±50 V, referred to chassis ±1500 V
- pulse voltage resistance of all lead electrode connections and of the neutral electrode connection referred to chassis (either polarity, e.g. defibrillation) 5000 V
- monitoring of each electrode for open leads: RA, LA, LL, RL, Vl, V2, V3, V4, V5, V6 audio signal at printer start

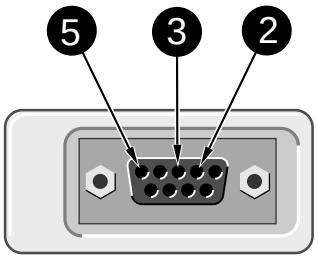
Data interface

one serial RS232 interface for exchange of data with suitable external devices and software handshake

RS232 interface (standard V.24 interface):

- input voltage range. ± 15V max.
- output voltage range ±5 V min.
- interface protected from electrostatic discharge for ±10 kV max.

Pin assignment of data port



2 RXDE

3 TXDE

5 circuit reference

Signal Transmission

Patient input to recording

After lead formation and digitization simultaneous transmission of all electrode signals to the digital processing system; muscle filter, AC filter, pacing pulse identification, automatic or manual sensitivity adjustment, automatic baseline adjustment and drift compensation by means of the anti-drift system (A.D.S.) can be enabled or disabled simultaneously for all channels; digital output of processed signals via thermal-array printhead.

- low cut-off frequency (-3 db limits) 0.08 Hz, equivalent to a time constant of 2.04 s
- high cut-off frequency (3 dB limits) operating mode: 12 Lead, 6 Lead 150 Hz (IEC/AHA) operating mode: Arrhy 100 Hz (IEC)
- signal sampling rate: 1000/s
- resolution, referred to the input 5 µV
- output rate to recorder 2000/s
- for all leads, gain adjustment in four steps: 40-20-10-5 mm/mV
- with active muscle filter (low-pass characteristic) 3-dB drop of the amplitude frequency response at approx. 40 or 20 Hz
- with active AC line filter detection and compensation of periodic 50 or 60 Hz frequency components (depending on recorder model) attenuation >40 dB
- non-linear distortion below values specified in IEC and AHA recommendations
- coincidence error limits between any two channels ±0.5 mm
- detection of pacer pulses in V2 or other V leads and marking in all channels for signals referred to patient input:
  duration ≥ 0.1 ms, amplitude > 5 mV
- noise in the signal transmission path below values specified in IEC and AHA requirements:
  ≤ 2.5 µV rms
- common-mode rejection for 50 or 60-Hz signals (depending on recorder model) with AC filter switched on >140 dB

ECG calibration

automatic recording of a defined voltage step, valid for all channels

- calibration voltage, referred to ECG signal input: l mV
  calibration pulse width on recording depends on paper speed
  25 mm/s 5 mm
  50 mm/s 10 mm
  5 mm/s l mm

Automatic ECG gain adjustment

The gain automatically adapts to the incoming signal. The maximum amplitude of the lead group or of all leads determines the gain setting.

- automatic adjustment range 5 to 40 mm/mV
- amplitude range (6 channels) 18 to 31 mm

Baseline

automatic adjustment of the baseline to the optimal recording range, in dependence of the signal amplitude

Anti-drift system (ADS) (cubic spline)

automatic compensation of baseline fluctuations caused by polarization voltage fluctuations at the lead electrodes (delay in recording: 4.2 s)

ECG storage

in 12 Lead Mode, storage of up to 40 ECGs

- stored ECGs can be deleted (individually or all in one pass), printed, transferred, and patient data can be edited
- when memory is full user is informed of the possible actions

Blocking

rapid charge reversal of the coupling capacitors in the preamplifiers after electrode application, ensures that the baseline is quickly restored to its original position after overranging

Electrode monitoring

audible and visual indication on the LCD of disconnected electrodes or line break; each single electrode is monitored

Text input

patient and user data as well as comments can be entered via the panel keyboard and are annotated on the recording strip

Copy function

after ECG recording in 12 Lead Mode, copies of the ECG can be printed from memory and/or transferred to a MUSE CV system (configurable)

Test

automatic performance test upon power up, including verification of the signal path starting at the signal input

stored test ECG data for demonstration of the device functions

Power supply

from the power line or from a built-in rechargeable battery, automatic switchover; automatic battery charging during line-power operation from integrated AC adapter module

Mains operation

- instrument design in protection class I according to IEC 60601-1
- Rated voltage range 95 to 240 V
- operating voltage range 85 to 264 V, 49 to 65 Hz
- rated current: 0.2 to 0.6 A
- fuse 2 x T1.25A, 5x20
- typical power consumption battery charging 14 W
- max. power consumption 29 W

Battery operation

- type: nickel-cadmium
- rated battery voltage 18 V
- rated battery capacity 1.3 Ah
- fully charged battery sufficient for up to 50 12 Lead Mode, 1-page ECGs, if unit is only switched on to record the ECGs
- battery charge time approx. 4 hours (min. charge time for one 12 Lead Mode ECG: 10 minutes)
- battery life approx. 2 to 3 years, replacement by service only
- lithium battery for built-in clock, battery life approx. 5 years, replacement by service only

Operational readiness

After successful self-test, approx. 10 s after power-up

Operating position

horizontal

Environment

Operation

- temperature between 50 and 104 °F
- relative humidity between 25 and 95%
- atmospheric pressure between 700 and 1060 hPa

Transport and storage

- temperature between -22 and +140 °F (including battery)
- relative humidity between 25 and 95%
- atmospheric pressure between 500 and 1060 hPa

Recorder dimensions

- width 14.5 in.
- height 3.7 in.
- depth 12.6 in. (incl. handle)

Weight

- approx. 12.3 lb (with battery)

For your notes

Index

—1—

12 Lead mode, brief operating instructions 33
12 Lead mode, system defaults 25
12 Lead mode, system setup 42

—6—

6 Lead mode, brief operating instructions 36
6 Lead mode, system defaults 34
6 Lead mode, system setup 44

—A—

AC line frequency 46
AC line interference 43; 53
Activating options 48
Anti-drift system 22; 44
Arrhythmia codes 40
Arrhythmia mode 37
Arrhythmia mode, brief operating instructions 40
Arrhythmia mode, system defaults 37
Arrhythmia mode, system setup 45
Arrhythmia recording 45
Automatic baseline adjustment 22

—B—

Battery, charging 16
Baud rate 47
Brief operating instructions, 12 Lead mode 33
Brief operating instructions, 6 Lead mode 36
Brief operating instructions, arrhythmia mode 40

—C—

Cart to cart communication 32
Caution, definition 12
Cleaning 51
Communication, system setup 47
Connecting external equipment 19
Contrast, adjustment 19
Controls, overview 10
Cubic spline 22

—D—

Danger, definition 12
Date 46
Defibrillation while recording ECG 20
Detailed results 29; 42
Disinfection 51
Display backlighting 46

—E—

ECG recording during defibrillation 41
ECG transmission (modem) 30
ECG transmission to MUSE CV system 32
Electrode placement 21
End of paper while printing 28
Entering patient data 23
Environment, operation 59
Environment, storage and transport 59
Event episodes 45
External equipment, connection 19

—F—

Final report 45
Functional description 9

—G—

General device settings 18
General information 6
General settings, system setup 46

—H—

Heart rate limit 36; 39
HOST-System 43

—I—

ID number, MUSE 47
Indicators, overview 10
Installation 17
Intended use 9

—L—

Language 46
Lead fail beep 46
Lead labels 46
Limb lead electrodes, application 20
Lithium battery 53

—M—

Mains connection 17
Maintenance 51
Medication 24
Memory (optional MEMO function) 28
Memory option 25
Modem 30
Modem setup 32
Muscle artifact 43
Muscle filter 43
MUSE CV Information System 19

—O—

Option codes 3; 48
Options, how to activate 48
Options, overview 9
Ordering physician 24
Override function 43

—P—

Pacemaker patient 41
Paper feed, automatic 44
Paper, inserting new pad 49
Patient data setup 48
Patient data, entry 23
Performance check 17
Physician, referring, ordering 24; 46
Power supply 16
Protocols 47

—R—

Receiving ECGs from the MUSE CV system 32
Recharging the battery 16
Recording in 12 Lead mode 26
Recording in 6 Lead mode 34
Recording in Arrhythmia mode 38
Recording problems 22
Referring physician 24
Report formats, 12 Lead mode 29
Revision code 2
Revision history 2

—S—

Safety information 12
Saving ECGs 28
Service parts, how to order 4
Service requests, where to call 5
Setup 42
Software version 2
Specifications 55
Standard leads 21
Supplies, how to order 4
Symbols, explanation 11
System defaults, 12 Lead mode 25
System defaults, 6 Lead mode 34
System defaults, arrhythmia mode 37
System setup, 12 Lead mode 42
System setup, 6 Lead mode 44
System setup, Arrhythmia mode 45
System setup, communication 47
System setup, general settings 46

—T—

Technical specifications 55
Technical support 4
Test DATA 46
Thermal paper, storage 50
Thorax electrodes, application 21
Time 46
Trend recording 45
Troubleshooting 53

—U—

Units 46

—W—

Warning, definition 12